

SUPPORTING INFORMATION FOR

Organocatalysis in the Three-Component Povarov Reaction and Investigation by Mass Spectrometry

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CONTENTS

SUPPORTING INFORMATION PART I

General Techniques *pages S2*
Experimental procedures *pages S3-S13*

SUPPORTING INFORMATION PART II

¹H NMR and ¹³C NMR spectra *pages S14-S27*
ESI-MS and ESI-MS/MS spectra *pages S28-S31*
APCI-MS and APCI-MS/MS spectra *pages S31-S34*
Chromatograms GC/MS *pages S35*
Determination of the major diastereoisomer *pages S35-S36*
References *pages S37*

GENERAL TECHNIQUES

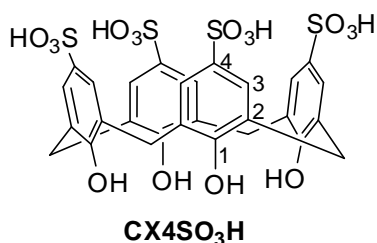
Unless noted, all commercial reagents were used as purchased without further purification. Column chromatography was carried out using 0.063-0.2 mm silica gel (DavisilR LC60A 40-63 Micron) with the indicated solvent. Thin layer chromatography (tlc) was carried out using 0.2 mm Kieselgel F254 (Merck) silica plates and compounds visualized using UV irradiation at 365 nm. Infrared spectra were recorded as neat using a FT-IR Varian 660 Fourier Transform Infrared spectrometer. Values are expressed in wavenumbers (cm^{-1}) and recorded in a range of 4000 to 450 cm^{-1} . NMR spectra were recorded at $25 \text{ }^\circ\text{C}$ in CDCl_3 or D_2O on a Varian Mercury 300 spectrometer operating at 300 MHz for ^1H and 75 MHz for ^{13}C . All chemical shifts are reported in parts per million (ppm) and were measured relative to the solvent in which the sample was analyzed. Coupling constants (J) are reported in Hertz (Hz).

The analysis and monitoring by mass spectrometry was performed on a Shimadzu LCMS-IT-TOF instrument working at high-resolution and high mass accuracy ($<5 \text{ ppm}$) under the following conditions: ESI ionization at 4.5 KV in simultaneous mode (positive and negative), nebulizer gas at $1.5 \text{ L}\cdot\text{min}^{-1}$, curved desorption line (CDL) interface at $200 \text{ }^\circ\text{C}$, and drying gas at 100 kPa; octapole ion accumulation time of 100 ms, precursor ion selected width of 3.0 amu, CID collision time of 30 ms, collision energy of 50% (62.5 mV, waveform voltage from 0 to peak), unless specified otherwise of $q=0.251$. Full scan mass spectra from m/z 50 to 500 were acquired with a scan time of 0.2 s. The samples were dissolved in methanol or acetonitrile and injected by direct infusion at a flow rate of 10 mL min^{-1} with automatic syringe pump.

Diastereoselectivity was determined for gas chromatography coupled to mass spectrometer using a SHIMADZU CG-17A mass spectrometer and method with the following specifications, column DB-5, 30 meters, DI 0.25 mm; carrier gas helium; injector temperature: $250 \text{ }^\circ\text{C}$; oven temperature was: $120 \text{ }^\circ\text{C}$ (1 min), ramped at $15 \text{ }^\circ\text{C min}^{-1}$ up to $300 \text{ }^\circ\text{C}$ (held for 20 minutes).

EXPERIMENTAL PROCEDURES

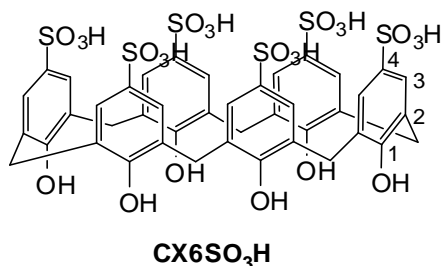
Catalysts *p*-sulfonic acid calix[4]arene and *p*-sulfonic acid calix[6]arene were prepared according to published method. ^1H NMR characterization for catalysts:



p-sulfonic acid calix[4]arene. White solid.

^1H NMR (300 MHz, D₂O): δ 3.88 (s, 8H), 7.42 (s, 8H).

^{13}C NMR (75 MHz, D₂O): δ 30.8 (ArCH₂Ar), 126.7 (C-2), 128.3 (C-3), 135.8 (C-4), 151.9 (C-1).



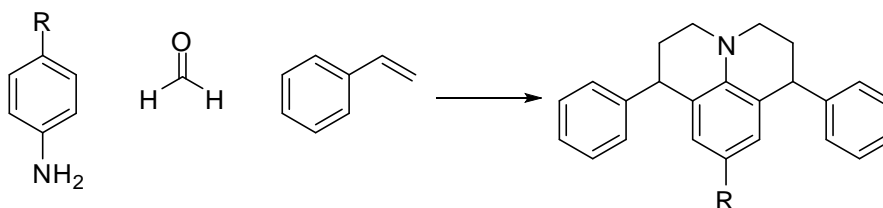
p-sulfonic acid calix[6]arene. A gray solid.

^1H NMR (300 MHz, D₂O): δ 3.83 (s, 12H), 7.34 (s, 12H).

^{13}C NMR (75 MHz, D₂O): δ 30.8 (CH₂), 126.4 (C-2), 128.0 (C-3), 135.3 (C-4), 153.2 (C-1).

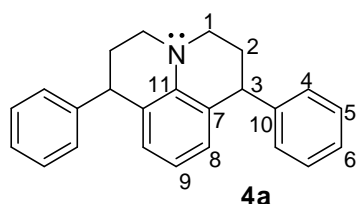
The NMR data for catalysts were in agreement with that reported in the literature.¹

The general procedure for obtaining the Julolidines is described below.



To a solution of *p*-sulfonic acid calix[4]arene (18.12 mg; 2 mol%) and aniline (1 mmol, 172 mg, 1 equiv) in water (5 mL) was added dropwise a heterogeneous mixture of styrene (0.349 mL; 3 mmol;

3 equiv) and formaldehyde 37% (0.244 mL; 3 mmol; 3 equiv) at room temperature. By adding styrene and formaldehyde, the reaction mixture becomes cloudy with formation of a precipitate. The reaction was carried out under stirring for two hours, and monitored by TLC. The product was extracted with dichloromethane (4 x 10 mL). The organic extracts were combined and the resulting organic phase was dried over Na₂SO₄ and the solvent removed under reduced pressure in a rotary evaporator. The solid obtained was subjected to column chromatography (hexane/dichloromethane) to afford the required product.



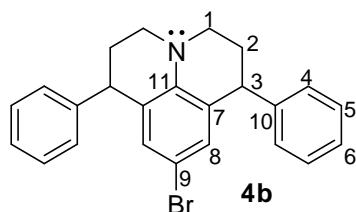
1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4a).² Column chromatography on silica gel (hexane / dichloromethane = 9:1 v/v) afforded 244 mg of title product in 75% yield as a light yellow oil.

¹H NMR (300 MHz; CDCl₃): δ 2.08-2.14 (m, 2H, H-**2α**); 2.24-2.28 (m, 2H, H-**2β**), 3.08-3.22 (m, 4H, H-**1**), 4.14 (dd, 2H, *J* = 6.0 Hz, *J* = 12.0 Hz, H-**3**), 7.09 (t, 1H, H-**9**), 7.14-7.19 (dt, 4H, *J* = 1.5 Hz, *J* = 6.3 Hz, H-**4**), 7.22-7.28 (m, 2H, H-**6**), 7.31-7.36 (m, 4H, H-**5**).

¹³C NMR (75 MHz; CDCl₃): δ 31.68 (C-**2**), 43.80/44.00 (C-**3**), 47.29/47.49 (C-**1**), 123.81/123.03 (C-**9**), 125.84/125.92 (C-**10**), 126.18 (C-**6**), 128.42 (C-**4**), 128.96 (C-**8**), 138.32/138.51 (C-**5**), 141.29/141.38 (C-**11**), 147.43/147.57 (C-**7**).

IR (cm⁻¹) $\bar{\nu}_{\max}$: 3061, 3024, 2949, 2860, 1668, 1454, 738, 700.

HRMS [ESI(+), IT-TOF] calculated for M+H = C₂₄H₂₄N 326.1800, found 326.0607.



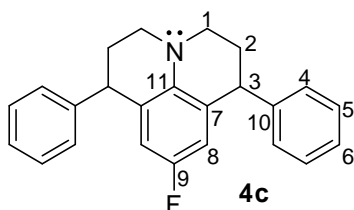
9-bromo-1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4b). Column chromatography on silica gel (hexane / dichloromethane = 9:1 v/v) afforded 282 mg of title product in 70% yield as a white solid. M.p. = 86.5-88.1 °C.

$^1\text{H NMR}$ (300 MHz; CDCl_3): δ 2.05-2.21 (m, 2H, H-**2 α**), 2.22-2.30 (m, 2H, H-**2 β**); 3.09-3.15 (m 4H, H-**1**), 4.11 (dd, 2H, $J = 6.0$ Hz, $J = 12.0$ Hz, H-**3**), 6.74 (s, 2H, H-**7**), 7.16 (dt, 4H, $J = 1.38$ Hz, $J = 6.10$ Hz, H-**4**), 7.24-7.26 (m, 2H, H-**6**), 7.30-7.35 (m, 4H, H-**5**).

$^{13}\text{C NMR}$ (75 MHz, CDCl_3): δ 30.58 (C-**2**), 43.52/43.60 (C-**3**), 47.23/47.30 (C-**1**), 107.47/107.61 (C-**9**), 125.72 (C-**6**), 126.57 (C-**5**), 128.06/128.78 (C-**4** and C-**7**), 131.08/131.11 (C-**8**), 142.34/142.41 (C-**11**), 146.17/146.24 (C-**10**).

$\text{IR (cm}^{-1}\text{)}$ $\bar{\nu}_{\text{max}}$: 3059, 3026, 2949, 2857, 1667, 1456, 736, 700.

$\text{HRMS [ESI(+), IT-TOF]}$ calculated for $\text{M}+\text{H} = \text{C}_{24}\text{H}_{23}\text{BrN}$ 404.1014, found 404.0607.



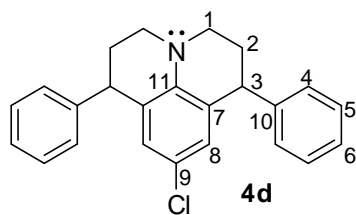
9-fluoro-1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4c). Column chromatography on silica gel (hexane / dichloromethane = 9:1 v/v) afforded 254 mg of title compound in 74% yield as a yellow oil.

$^1\text{H NMR}$ (300 MHz, CDCl_3) δ 1.98-2.19 (m, 2H, H-**2 α**), 2.28-2.34 (m, 2H, H-**2 β**), 2.99-3.08 (m, 4H, H-**1**), 4.05 (dd, 2H, $J = 6.0$ Hz, $J = 12.0$ Hz, H-**3**), 6.25 (dd, 2H, $J_{\text{H-F}} = 9.3$ Hz, $J = 0.7$ Hz, H-**8**), 7.06-7.10 (dt, 4H, $J = 1.5$ Hz, $J = 7.0$ Hz, H-**4**), 7.11-7.20 (m, 2H, H-**6**), 7.21-7.26 (m, 4H, H-**5**).

$^{13}\text{C NMR}$ (75 MHz, CDCl_3): δ 31.17/31.27 (C-**2**), 43.97/44.04 (C-**1**), 47.82/48.09 (C-**3**), 114.91/114.98 (C-**8**), 125.42/125.50 (C-**7**), 125.57 (C-**6**), 128.66 (C-**5**), 128.90 (C-**4**), 140.11 (C-**11**), 146.55/146.63 (C-**10**), 153.26/156.36 (C-**9**, $J_{\text{C-F}} = 232$ Hz).

$\text{IR (cm}^{-1}\text{)}$ $\bar{\nu}_{\text{max}}$: 3024, 2922, 2853, 1597, 1491, 1452, 750, 698.

$\text{HRMS [ESI(+), IT-TOF]}$ calculated for $\text{M}+\text{H} = \text{C}_{24}\text{H}_{23}\text{NF}$ 344.1815, found 344.1496.



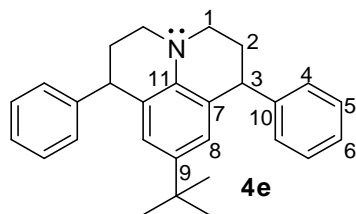
9-chloro-1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4d). Column chromatography on silica gel (hexane / dichloromethane = 85:15 v/v) afforded 273 mg of title compound in 76% yield as a yellow solid. M. p. = 89.0-92.2 °C.

¹H NMR (300 MHz; CDCl₃): δ 2.09-2.17 (m, 2H, H-2 α), 2.23-2.33 (m, 2H, H-2 β), 3.12-3.18 (m, 4H, H-1), 4.14 (dd, 2H, *J* = 6.0 Hz, *J* = 12.0 Hz, H-3), 6.61 (s, 2H, H-7), 7.17 (dt, 4H, *J* = 1.5 Hz, *J* = 9.0 Hz, H-4), 7.22-7.28 (m, 2H, H-6), 7.30-7.38 (m, 4H, H-5).

¹³C NMR (75 MHz, CDCl₃): δ 30.68 (C-2), 43.62/43.67 (C-3), 47.36/47.45 (C-1), 120.32/120.44 (C-9), 125.32 (C-6), 126.58 (C-5), 128.28/128.31 (C-4), 128.67 (C-7), 128.82 (C-8), 141.97/142.03 (C-11), 146.25/146.28 (C-10).

IR (cm⁻¹) $\bar{\nu}_{\max}$: 3054, 3027, 2953, 2857, 1667, 1455, 736, 700.

HRMS [ESI(+), IT-TOF] calculated for M+H = C₂₄H₂₃NCl 360.1519, found 360.1473.



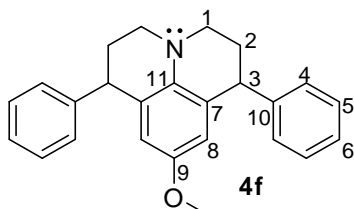
9-tert-butyl-1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4e). Column chromatography on silica gel (hexane / dichloromethane = 9:1 v/v) afforded 305 mg of title compound in 80% yield as a yellow oil.

¹H NMR (300 MHz, CDCl₃): δ 1.07 (s, 9H, CH₃), 2.11-2.17 (m, 2H, H-2 α), 2.31-2.37 (m, 2H, H-2 β), 3.07-3.19 (m, 4H, H-1), 4.22 (dd, 2H, *J* = 6.0 Hz, *J* = 12.0 Hz, H-3), 6.69 (s, 2H, H-8), 7.16-7.35 (m, 10H, H-4, H-5 e H-6).

¹³C NMR (75 MHz; CDCl₃): δ 31.40 (C-2), 31.60 (CH₃), 33.90 (C), 43.80/44.60 (C-3), 47.29/47.49 (C-1), 122.81/123.03 (C-7), 125.84/125.92 (C-8), 126.18 (C-6), 128.42 (C-4), 128.96 (C-5), 138.32/138.51 (C-9), 141.29/141.38 (C-11), 147.43/147.57 (C-10).

IR (cm⁻¹) $\bar{\nu}_{\max}$: 3030, 2951, 2863, 1612, 1505, 1361, 1299, 736, 700.

HRMS [ESI(+), IT-TOF] calculated for M+H = C₂₈H₃₁N 382.2535, found 382.2203.



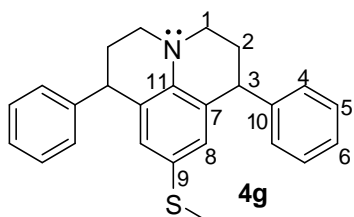
9-methoxy-1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4f). Column chromatography on silica gel (hexane / dichloromethane = 8:2 v/v) afforded 295 mg of title compound in 83% yield as a yellow oil.

¹H NMR (300 MHz, CDCl₃): δ 2.06-2.13 (m, 2H, H-2 α), 2.23-2.27 (m, 2H, H-2 β), 3.06-3.14 (m, 4H, H-1), 3.63 (s, 3H, OCH₃), 4.11 (t, 2H, *J* = 6.5 Hz, H-3), 6.37 (s, 2H, H-8), 6.63-6.72 (m, 4H, H-5), 7.13-7.31 (m, 6H, H-4 and H-6).

¹³C NMR (75 MHz; CDCl₃): δ 31.85 (C-2), 43.99/44.10 (C-3), 49.21 (C-1), 55.90 (OCH₃), 112.71/123.03 (C-7), 113.19 (C-8), 116.19 (C-6), 126.36 (C-4), 128.52 (C-5), 142.02 (C-11), 146.71 (C-10), 151.46 (C-9).

IR (cm⁻¹) $\bar{\nu}_{\max}$: 3030, 2924, 2823, 1490, 1453, 1299, 1152, 1090, 1317, 754, 699.

HRMS [ESI(+), IT-TOF] calculated for M+H = C₂₅H₂₆NO 356.2014, found 356.1690.



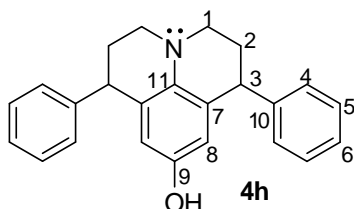
9-(methylthio)-1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4g). Column chromatography on silica gel (hexane / dichloromethane = 80:20 v/v) afforded 330 mg of title compound in 89% yield as a yellow solid. M. p. = 89.5-90.7 °C.

¹H NMR (300 MHz, CDCl₃): δ 2.06-2.18 (m, 2H, H-2 α), 2.21 (s, 3H, SCH₃), 2.23-2.30 (m, 2H, H-2 β), 3.10-3.16 (m, 4H, H-1), 4.14 (dd, 2H, *J* = 6.0 Hz, *J* = 12.0 Hz, H-3), 6.72 (s, 2H, H-8), 7.16-7.38 (m, 10H, H-4, H-5 e H-6).

^{13}C NMR (75 MHz, CDCl_3): δ 19.16/19.28 (SCH_3), 30.71/30.77 (C-2), 43.56/44.68 (C-3), 47.34 (C-1), 122.09 (C-7), 124.35/124.40 (C-8), 126.45 (C-6), 128.60 (C-4), 128.87 (C-5), 130.67/130.87 (C-9), 142.35 (C-11), 146.57/146.67 (C-10).

IR (cm^{-1}) $\bar{\nu}_{\text{max}}$: 3026, 2920, 2854, 1592, 1491, 1450, 1312, 1029, 761, 728, 698.

HRMS [ESI(+), IT-TOF] calculated for $\text{M}+\text{H} = \text{C}_{25}\text{H}_{26}\text{NS}$ 372.1786, found 372.1459.



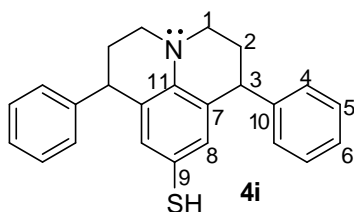
1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinolin-9-ol (4h). Column chromatography on silica gel (hexane / dichloromethane = 2:1 v/v) afforded 232 mg of title compound in 68% yield as a yellow oil.

^1H NMR (300 MHz, CDCl_3): δ 2.05-2.15 (m, 2H, H-2 α), 2.22-2.32 (m, 2H, H-2 β), 3.09-3.20 (m, 4H, H-1), 4.13 (dd, 2H, $J = 6.0$ Hz, $J = 12.0$ Hz, H-3), 6.74 (s, 2H, H-8), 7.16 (dt, 4H, $J = 1.38$ Hz, $J = 6.06$ Hz, H-4), 7.24-7.26 (m, 2H, H-6), 7.30-7.35 (m, 2H, H-5).

^{13}C NMR (75 MHz; CDCl_3): δ 30.58 (C-2), 43.52/43.60 (C-1), 47.23/47.30 (C-3), 107.47/107.61 (C-8), 125.72 (C-7), 126.57 (C-6), 128.06/128.78 (C-5), 131.08/131.11 (C-4), 142.34/142.41 (C-10), 146.17/146.24 (C-9).

IR (cm^{-1}) $\bar{\nu}_{\text{max}}$: 3345, 2921, 2854, 1725, 1606, 1490, 1445, 1239, 702.

HRMS [ESI(+), IT-TOF] calculated for $\text{M}+\text{H} = \text{C}_{24}\text{H}_{24}\text{NO}$ 342.1858, found 342.1547.



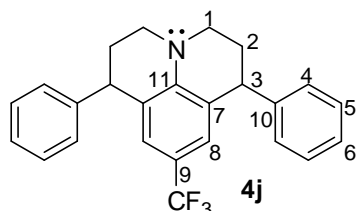
1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline-9-thiol (4i). Column chromatography on silica gel (hexane/dichloromethane = 7:3 v/v) afforded 228 mg of title compound in 64% yield as a yellow oil.

$^1\text{H NMR}$ (300 MHz, CDCl_3): δ 2.13-2.18 (m, 2H, H-**2 α**), 2.28-2.35 (m, 2H, H-**2 β**), 3.16-3.20 (m, 4H, H-**1**), 3.57 (SH) 4.17 (dd, 2H, $J = 6.0$ Hz, $J = 12.0$ Hz, H-**3**), 6.79 (s, 2H, H-**8**), 7.15-7.36 (m, 10H, H-**4**, H-**5**, H-**6**).

$^{13}\text{C NMR}$ (75 MHz; CDCl_3): δ 30.71/30.77 (C-**2**), 43.56/43.68 (C-**1**), 47.34 (C-**3**), 124.35/124.40 (C-**8**), 126.45 (C-**7**), 128.60 (C-**6**), 128.76/128.87 (C-**5**), 130.67/130.85 (C-**4**), 142.35 (C-**10**), 146.57/146.67 (C-**9**).

$\text{IR (cm}^{-1}\text{)}$ $\bar{\nu}_{\text{max}}$: 3345, 2921, 2854, 1725, 1606, 1490, 1445, 1239, 702.

$\text{HRMS [ESI(+), IT-TOF]}$ calculated for $\text{M}+\text{H} = \text{C}_{24}\text{H}_{24}\text{NS}$ 358.1629, found 358.1494.



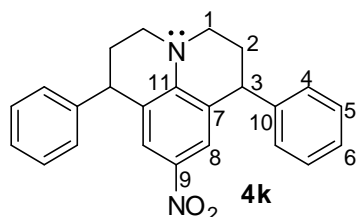
1,7-diphenyl-9-(trifluoromethyl)-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij] (**4j**). Column chromatography on silica gel (hexane / dichloromethane = 8:2 v/v) afforded 275 mg of title compound in 70% yield as a yellow oil.

$^1\text{H NMR}$ (300 MHz, CDCl_3): δ 2.06-2.17 (m, 2H, H-**2 α**), 2.22-2.33 (m, 2H, H-**2 β**), 3.16-3.23 (m, 4H, H-**1**), 4.19 (dd, 2H, $J = 6.0$ Hz, $J = 12.0$ Hz, H-**3**), 6.91 (s, 2H, H-**8**), 7.06-7.16 (m, 4H, H-**4**), 7.22-7.29 (m, 4H, H-**6**), 7.31-7.41 (m, 4H, H-**5**).

$^{13}\text{C NMR}$ (75 MHz, CDCl_3): δ 29.94 (C-**2**), 43.36/43.47 (C-**3**), 46.84/46.94 (C-**1**), 116.26 (C-**7**), 122.73 (C-**8**), 125.66 (C-**6**), 126.63/126.66 (C-**4**), 128.65 (C-**5**), 128.70 (C-**9**), 128.73 (C-**10**), 145.67/145.83 (C-**11**).

$\text{IR (cm}^{-1}\text{)}$ $\bar{\nu}_{\text{max}}$: 3026, 2932, 2853, 1597, 1491, 1452, 750, 698.

$\text{HRMS [ESI(+), IT-TOF]}$ calculated for $\text{M}+\text{H} = \text{C}_{25}\text{H}_{23}\text{NF}$ 394.1783, found 394.1741.



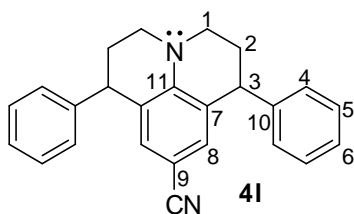
9-nitro-1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline (4k).³ Column chromatography on silica gel (hexane / dichloromethane = 6:4 v/v) afforded 270 mg of title compound in 73% yield as a yellow solid. M. p. = 128.8-129.7 °C.

¹H NMR (300 MHz, CDCl₃): δ 2.27-2.31 (m, 2H, H-2 α), 2.47-2.50 (m, 2H, H-2 β), 3.31-3.34 (m, 4H, H-1), 4.07 (dd, 2H, *J* = 6.0 Hz, *J* = 12.0 Hz, H-3), 7.08-7.33 (m, 12H, H-4, H-5, H-6 and H-8).

¹³C NMR (75 MHz, CDCl₃): δ 29.71 (C-2), 47.21/47.27 (C-3), 49.83/50.03 (C-1), 117.44/117.69 (C-8), 126.79 (C-6), 129.11 (C-5), 129.26/129.58 (C-4), 131.02/131.21 (C-7), 139.91 (C-9), 144.84/144.96 (C-10), 149.67/149.84 (C-11).

IR (cm⁻¹) $\bar{\nu}_{\max}$: 3039, 2977, 2621, 1630, 1493, 1155, 1034, 814, 622.

HRMS [ESI(+), IT-TOF] calculated for M+H = C₂₄H₂₃N₂O₂ 371.1760, found 371.1738.



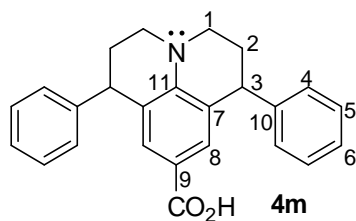
1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline-9-carbonitrile (4l). Column chromatography on silica gel (hexane / dichloromethane = 6:4 v/v) afforded 252 mg of title compound in 72% yield as a white solid. M. p. = 136.5-137.8 °C.

¹H NMR (300 MHz, CDCl₃): δ 2.05-2.14 (m, 2H, H-2 α), 2.20-2.29 (m, 2H, H-2 β), 3.16-3.24 (m, 4H, H-1), 4.17 (dd, 2H, *J* = 6.0 Hz, *J* = 12.0 Hz, H-3), 7.10-7.43 (m, 12H, H-4, H-5, H-6 and H-8).

¹³C NMR (75 MHz; CDCl₃): δ 29.51 (C-2); 43.06/43.18 (C-3); 47.77/47.93 (C-1); 114.89 (C-9); 114.89/115.06 (CN); 122.06 (C-8); 126.53 (C-6); 128.56 (C-7); 128.65 (C-5); 131.27/131.34 (C-4); 145.54/145.76 (C-10); 147.24 (C-11).

IR (cm⁻¹) $\bar{\nu}_{\max}$: 3366, 3027, 2953, 2924, 2853

HRMS [ESI(+), IT-TOF] calculated for M+H = C₂₅H₂₃N₂ 351.1861, found 351.1834.



1,7-diphenyl-1,2,3,5,6,7-hexahydropyrido[3,2,1-ij]quinoline-9-carboxylic acid (4m).³ Column chromatography on silica gel (hexane / dichloromethane = 1:1 v/v) afforded 255 mg of title compound in 69% yield as a white solid. M. p.= 256.9-257.1 °C.

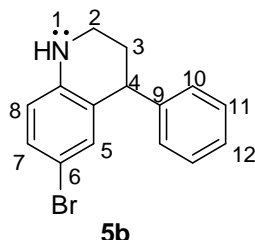
¹H NMR (300 MHz, CDCl₃): δ 2.05-2.15 (m, 2H, H-2), 2.19-2.20 (m, 2H, H-2), 3.16-3.24 (m, 4H, H-1), 4.19 (dd, 2H, *J* = 6.0 Hz, *J* = 12.0 Hz, H-3), 7.07-7.43 (m, 12H, H-4, H-5, H-6 and H-8).

¹³C NMR (75 MHz, CDCl₃): δ 29.59 (C-2), 43.18 (C-3), 46.77 (C-1), 114.89/115.06 (C-7), 122.06 (C-8), 126.53/126.57 (C-6), 128.56 (C-4), 128.65 (C-5), 131.27/131.34 (C-9), 145.54/145.76 (C-10), 147.24/147.32 (C-11), 172.43/172.46 (C=O).

IR (cm⁻¹) $\bar{\nu}_{\max}$: 3026, 2922, 2850, 2538, 2362, 1652, 1599, 1520, 1426, 1260, 1200, 770, 697.

HRMS [ESI(-), IT-TOF] calculated for M-H = C₂₅H₂₂NO₂ 368.1651, found 368.1702.

Structure of tetrahydroquinolines related in work



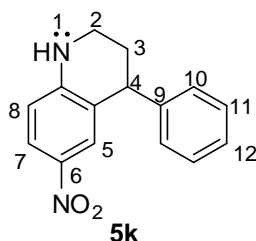
6-bromo-4-phenyl-1,2,3,4-tetrahydroquinoline (5b). A yellow oil. 100 mg isolated from column chromatography on silica gel (hexane / dichloromethane = 9:1 v/v) of obtaining **5b**, when employed to equimolar proportions of reactants. (Yield = 35%)

¹H NMR (300 MHz; CDCl₃): δ 1.97-2.22 (m, 2H, H-3), 3.17-3.28 (m, 2H, H-2), 4.10 (t, 1H, *J* = 6.0 Hz, H-4), 6.43 (d, 1H, *J* = 9.0 Hz, H-8), 7.07-7.34 (m, 7H, H-5, H-7, H-10, H-11 and H-12).

¹³C NMR (75 MHz; CDCl₃): δ 30.77 (C-3), 39.12 (C-2), 42.28 (C-4), 115.85 (C-6), 110.01 (C-8), 126.61 (C-12), 126.74 (C-4'), 126.61 (C-11), 128.66 (C-5), 128.72 (C-10), 130.28 (C-7), 139.26 (C-9), 132.94 (C-8').

IR (cm^{-1}) $\bar{\nu}_{\text{max}}$: 3363, 3029, 2952, 1606, 1489, 1240, 1029, 649, 700.

HRMS [ESI(+), IT-TOF] calculated for $\text{M}+\text{H} = \text{C}_{15}\text{H}_{15}\text{BrN}$ 288.0388, found 288.0090.



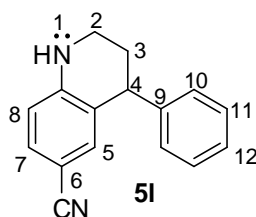
6-nitro-4-phenyl-1,2,3,4-tetrahydroquinoline (5k). A yellow solid. M. p. = 149.0-152.1 °C. 119 mg obtained from column chromatography on silica gel (hexane / dichloromethane = 1:2 v/v) of the reaction employing *p*-nitroaniline with time of two hours. (Yield = 48%)

^1H NMR (300 MHz; CDCl_3): δ 2.02-2.22 (m, 2H, H-3), 3.28-3.41 (m, 2H, H-2), 4.15 (t, 1H, $J = 6.0$ Hz, H-4), 6.47 (d, 1H, $J = 9.0$ Hz, H-8), 7.07-7.35 (m, 5H, H-10, H-11 and H-12), 7.73 (d, 1H, $J = 2.4$ Hz, H-7), 7.95 (dd, 1H, $J = 2.7$ Hz, $J = 9.0$ Hz, H-5).

^{13}C NMR (75 MHz; CDCl_3): δ 29.24 (C-3), 38.72 (C-2), 42.31 (C-4), 122.54 (C-8), 121.89 (C-4'), 122.15 (C-7), 124.62 (C-5), 126.81 (C-12), 126.99 (C-9), 128.27 (C-10), 128.67 (C-11), 144.26 (C-6), 150.34 (C-8').

IR (cm^{-1}) $\bar{\nu}_{\text{max}}$: 3411, 3039, 2877, 2621, 1630, 1493, 1155, 1034, 814, 622, 438.

HRMS [ESI(+), IT-TOF] calculated for $\text{M}+\text{H} = \text{C}_{16}\text{H}_{15}\text{N}_2\text{O}_2$ 254.1135, found 254.0981.



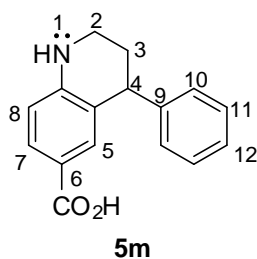
4-phenyl-1,2,3,4-tetrahydroquinoline-6-carbonitrile (5l). A white solid. M. p. = 166.9-167.8 °C. 122 mg obtained from column chromatography on silica gel (hexane / dichloromethane = 1:2 v/v) of the reaction employing *p*-cyanoaniline with time of two hours. (Yield = 52%)

^1H NMR (300 MHz; CDCl_3): δ 2.03-2.21 (m, 2H, H-3), 3.26-3.38 (m, 2H, H-2), 4.07 (t, 1H, $J = 6.0$ Hz, H-4), 6.54 (d, 1H, $J = 8.4$ Hz, H-8), 7.00-7.35 (m, 7H, H-5, H-7, H-10, H-11 and H-12).

^{13}C NMR (75 MHz; CDCl_3): δ 29.46 (C-3), 38.99 (C-2), 42.35 (C-4), 98.38 (C-6), 113.87 (C-8), 120.59 (CN), 123.56 (C-4'), 126.76 (C-12), 128.36 (C-11), 128.63 (C-10), 131.55 (C-5), 134.33 (C-7), 144.46 (C-9), 147.85 (C-8').

IR (cm^{-1}) $\bar{\nu}_{\text{max}}$: 3474, 3343, 3025, 2916, 2848, 2853, 2205, 1594, 1513, 1316, 1171, 821, 540.

HRMS [ESI(+), IT-TOF] calculated for $\text{M}+\text{H} = \text{C}_{16}\text{H}_{15}\text{N}_2$ 235.1235, found 235.0981.



4-phenyl-1,2,3,4-tetrahydroquinoline-6-carboxylic acid (5m). A rose oil. 106 mg obtained from column chromatography on silica gel (hexane / dichloromethane = 1:3 v/v) of the reaction employing *p*-carboxyaniline with time of two hours. (Yield = 42%)

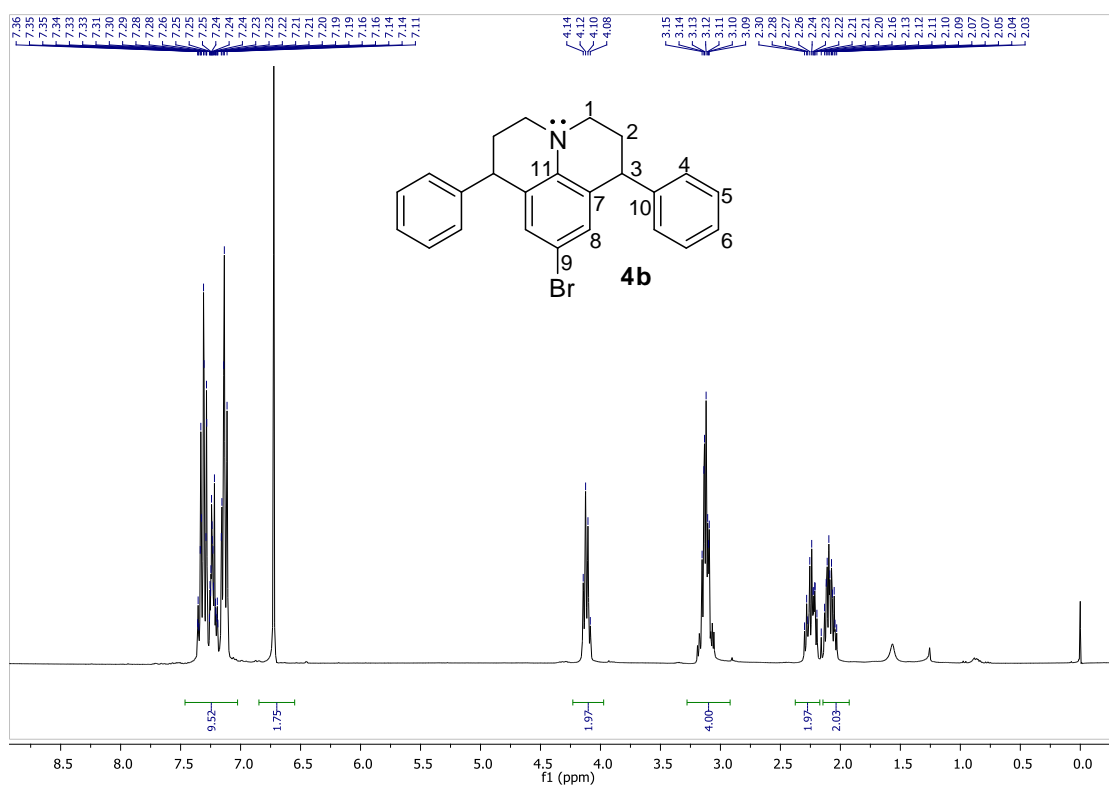
^1H NMR (300 MHz; CDCl_3): δ 1.99-2.21 (m, 2H, H-3), 3.10-3.28 (m, 2H, H-2), 4.10 (t, 1H, $J = 5.8$ Hz, H-4), 6.44 (d, 1H, $J = 9.0$ Hz, H-8), 6.85-7.38 (m, 7H, H-5, H-7, H-10, H-11 and H-12).

^{13}C NMR (75 MHz; CDCl_3): δ 29.59 (C-3), 43.18 (C-2), 46.77 (C-4), 114.89 (C-8), 122.06 (C-6), 126.53 (C-4'), 128.56 (C-12), 128.65 (C-11), 131.27 (C-10), 131.34 (C-7), 145.54 (C-5), 145.76 (C-9), 147.24 (C-8'), 172.46 (C=O).

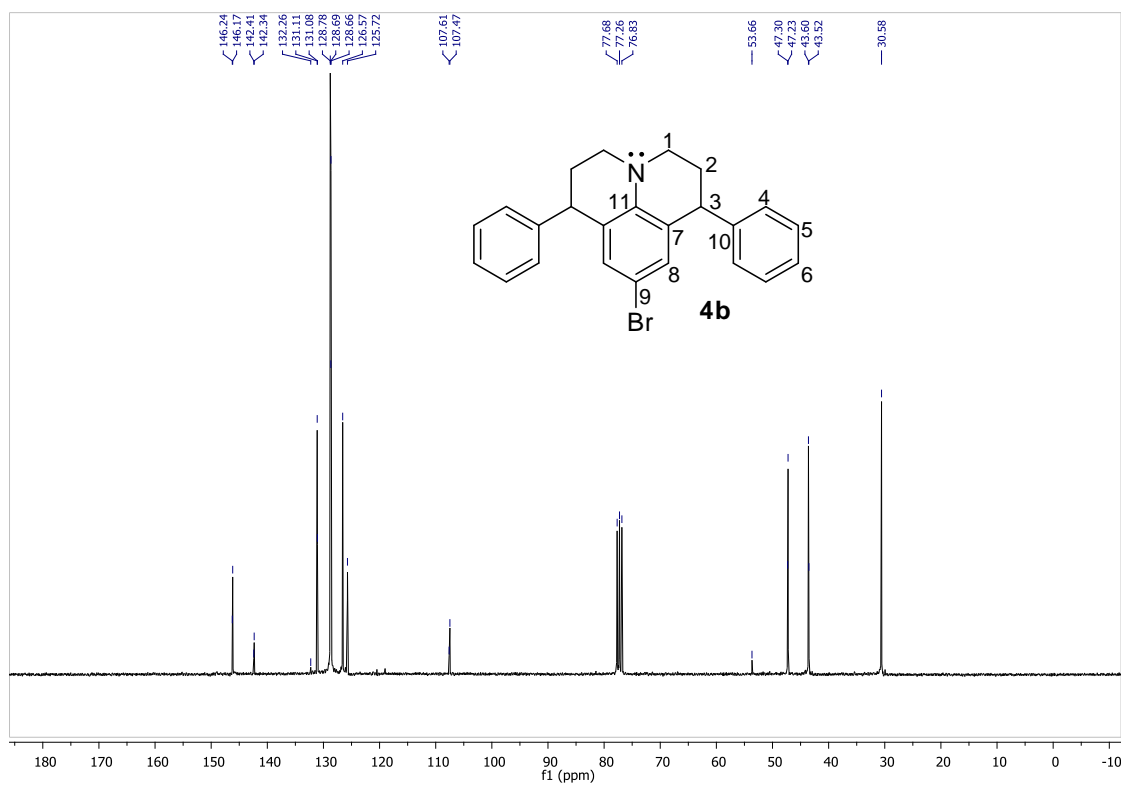
IR (cm^{-1}) $\bar{\nu}_{\text{max}}$: 3355, 3026, 2946, 2858, 2805, 1726, 1491, 1445, 1239, 826, 703, 559.

HRMS [ESI(-), IT-TOF] calculated for $\text{M}-\text{H} = \text{C}_{16}\text{H}_{14}\text{NO}_2$ 252.1025, found 252.1090.

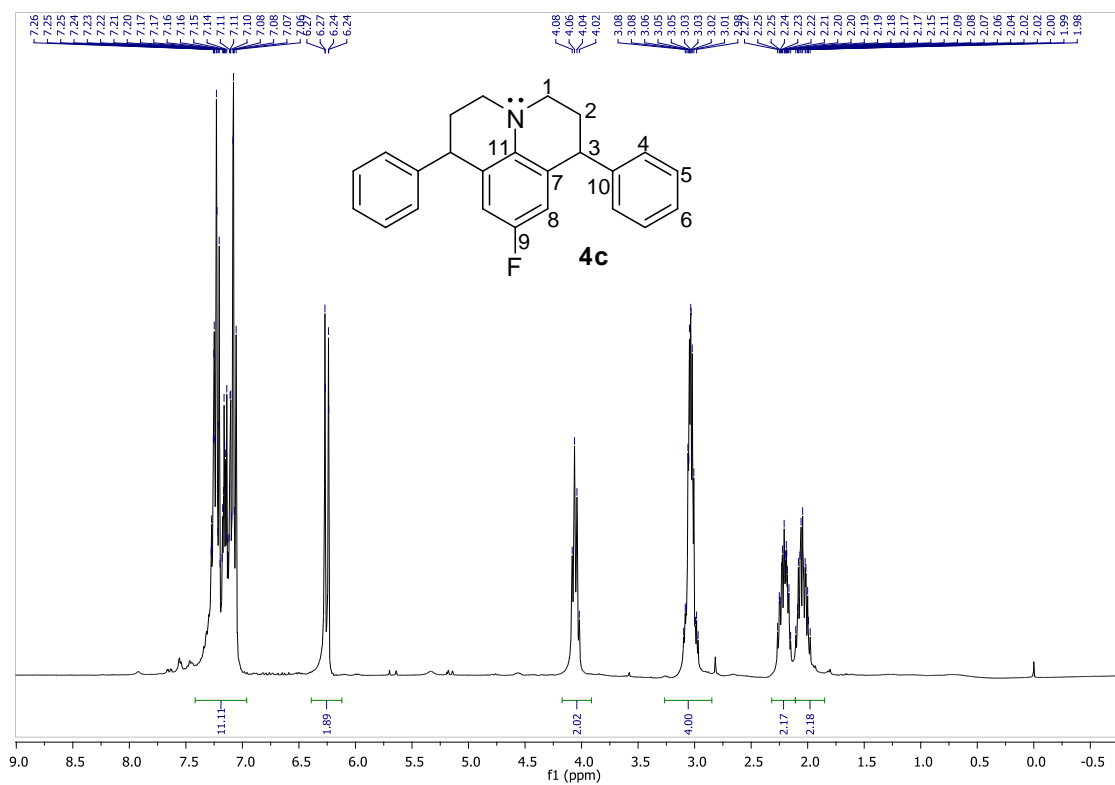
^1H NMR AND ^{13}C NMR SPECTRA FOR NEW COMPOUNDS



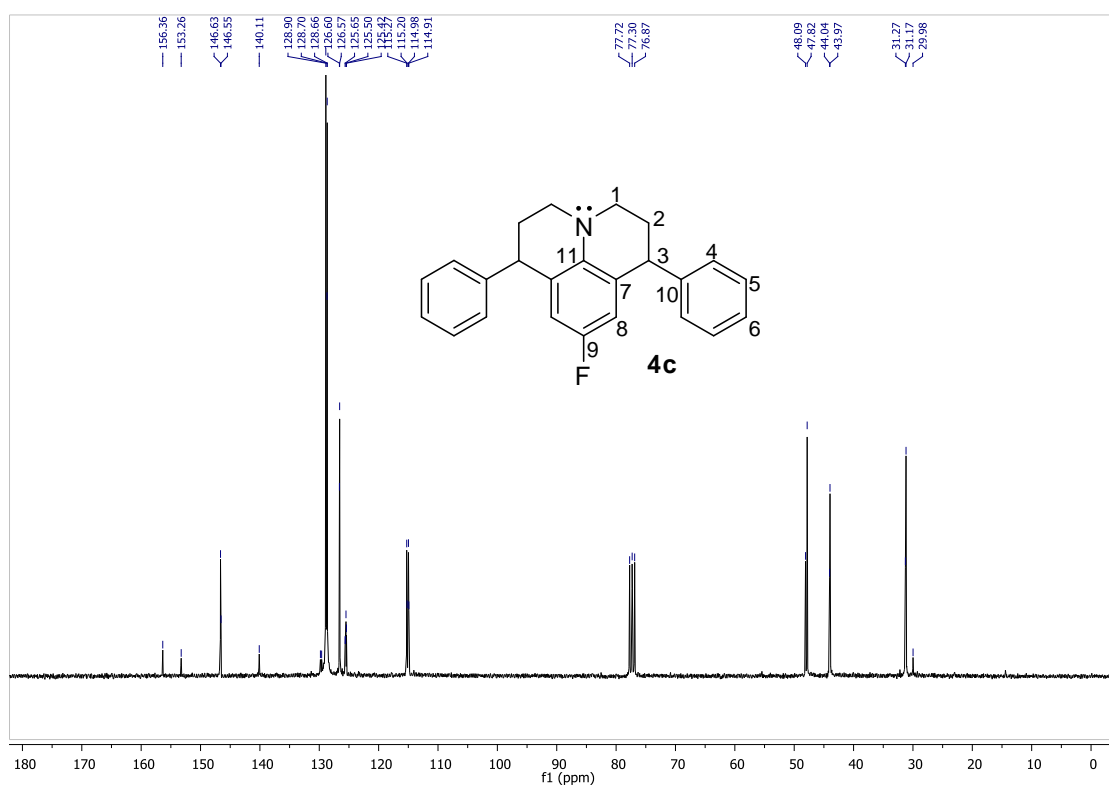
^1H NMR (300 MHz, CDCl_3) of **4b**.



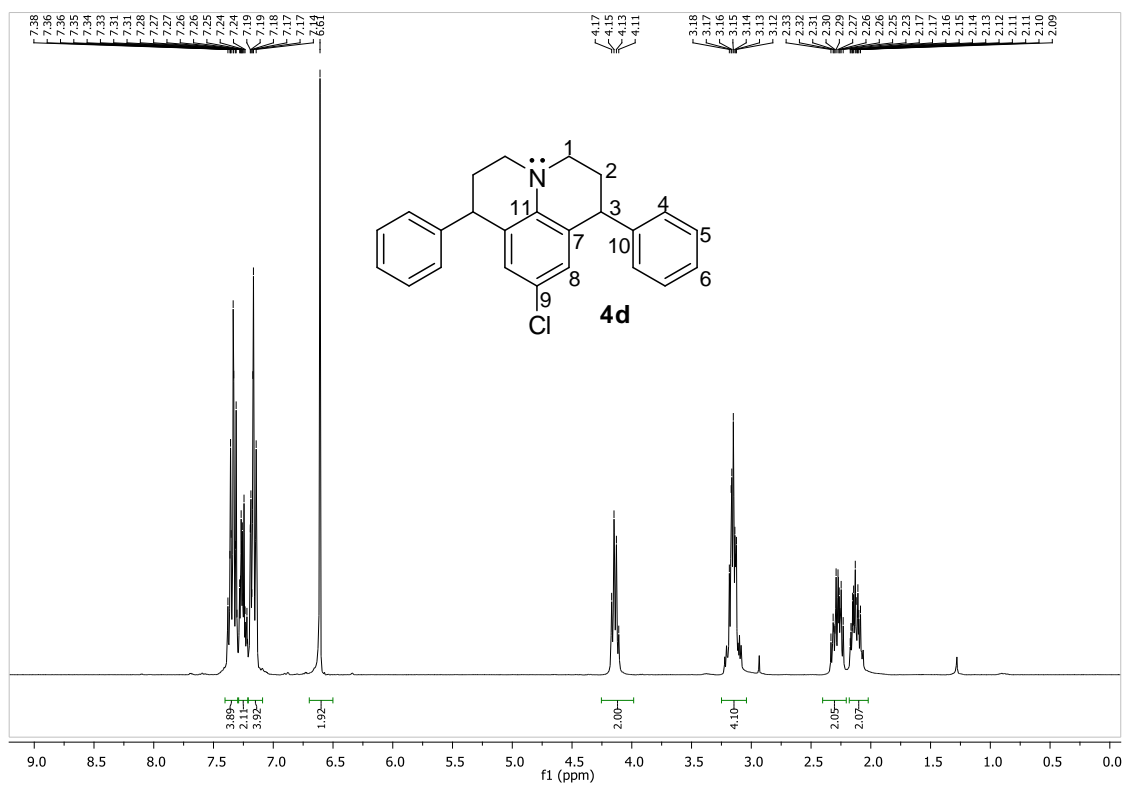
^{13}C NMR (75 MHz, CDCl_3) of **4b**.



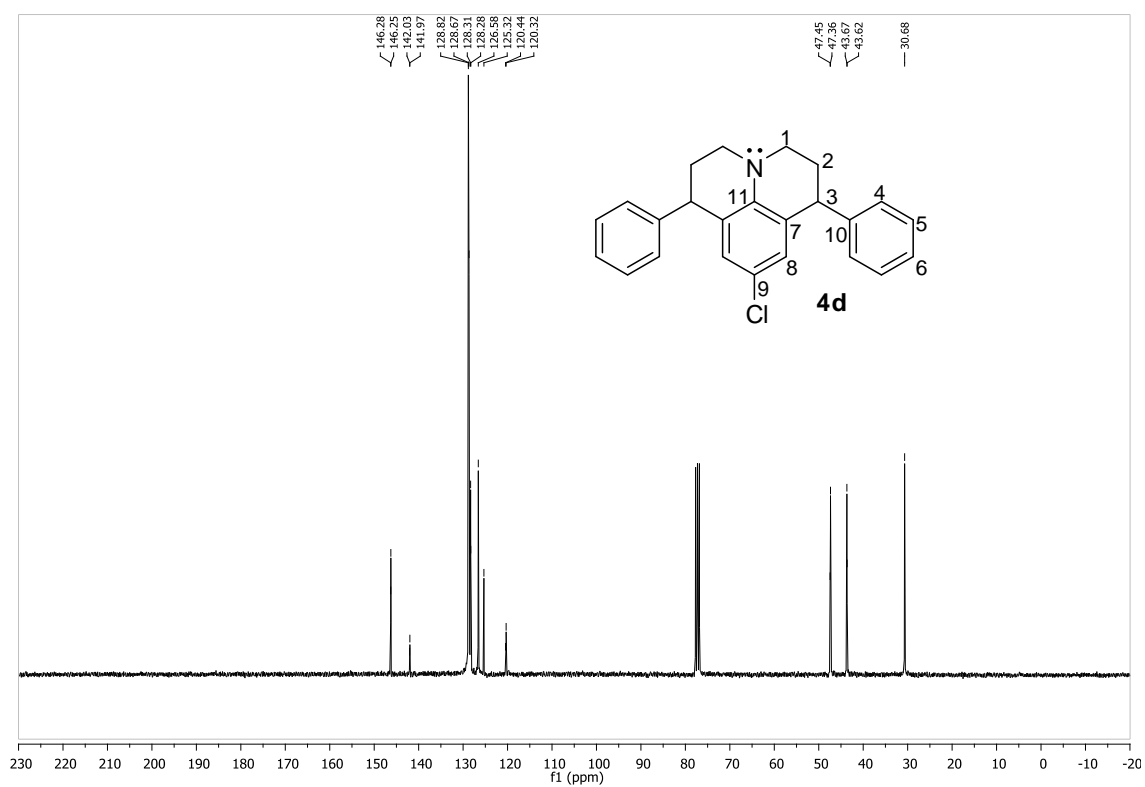
¹H NMR (300 MHz, CDCl₃) of **4c**.



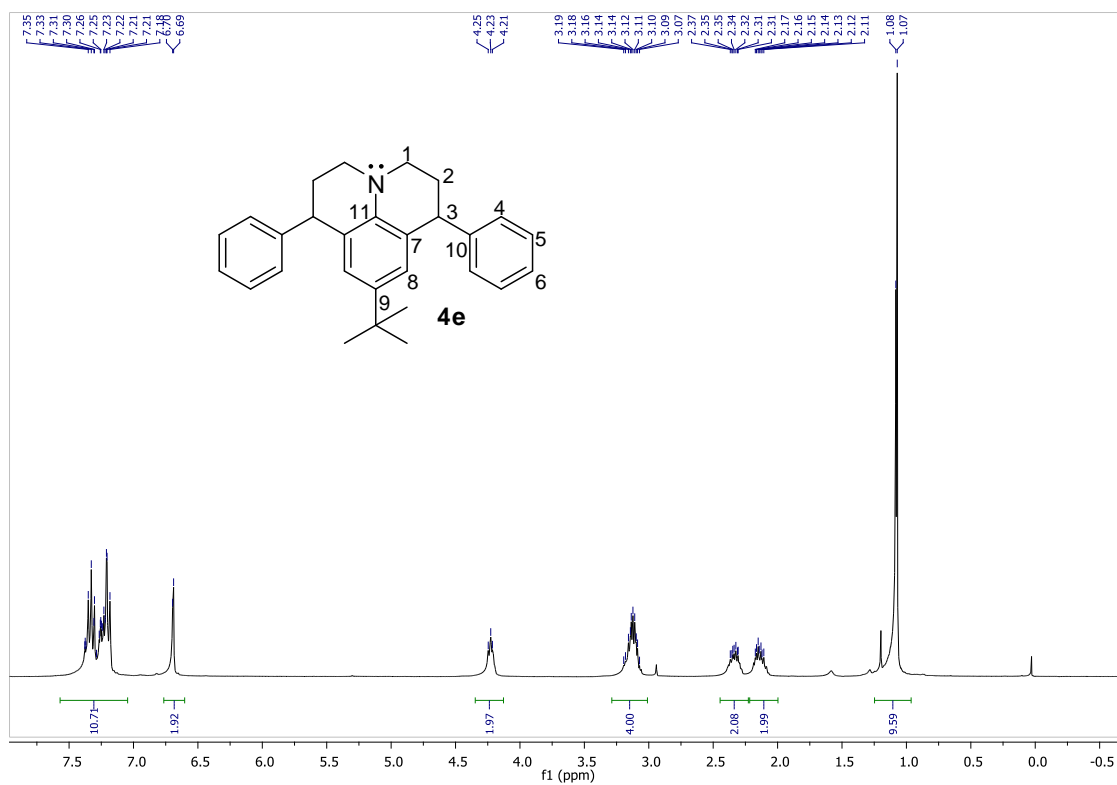
¹³C NMR (75 MHz, CDCl₃) of **4c**.



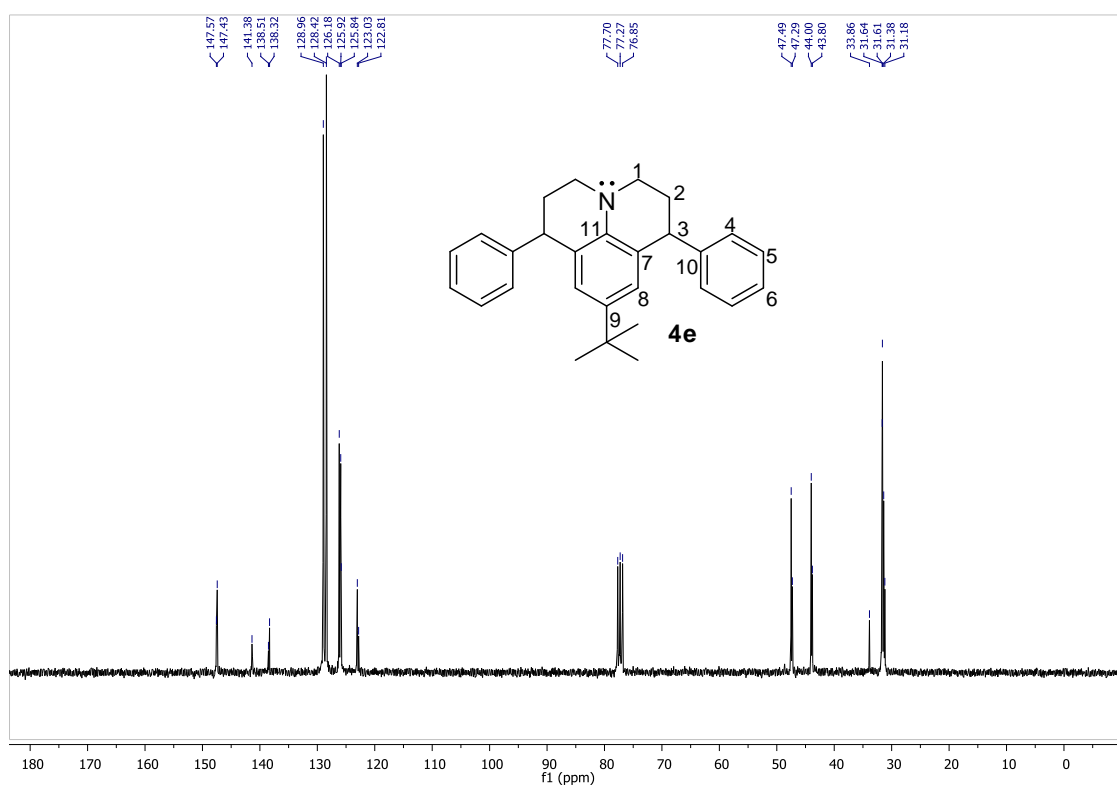
¹H NMR (300 MHz, CDCl₃) of **4d**.



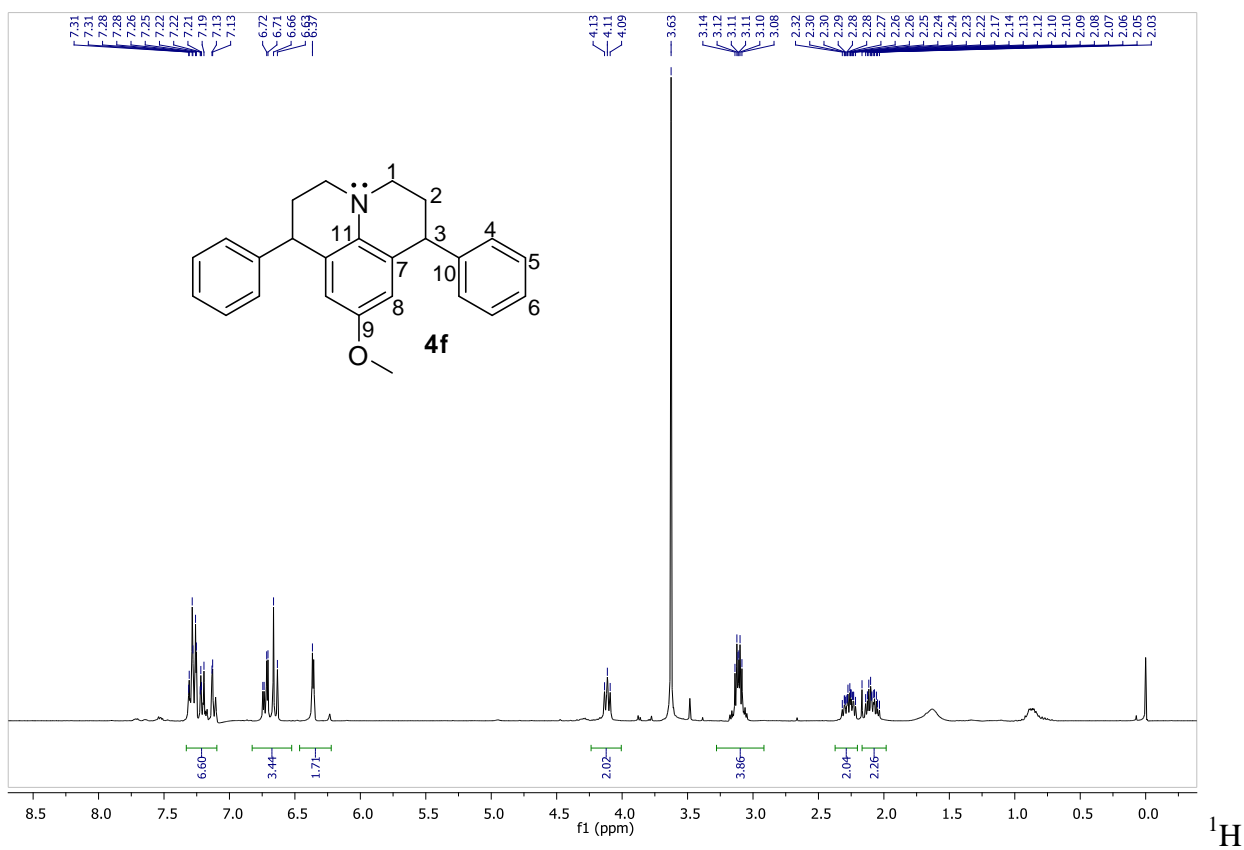
¹³C NMR (75 MHz, CDCl₃) of **4d**.



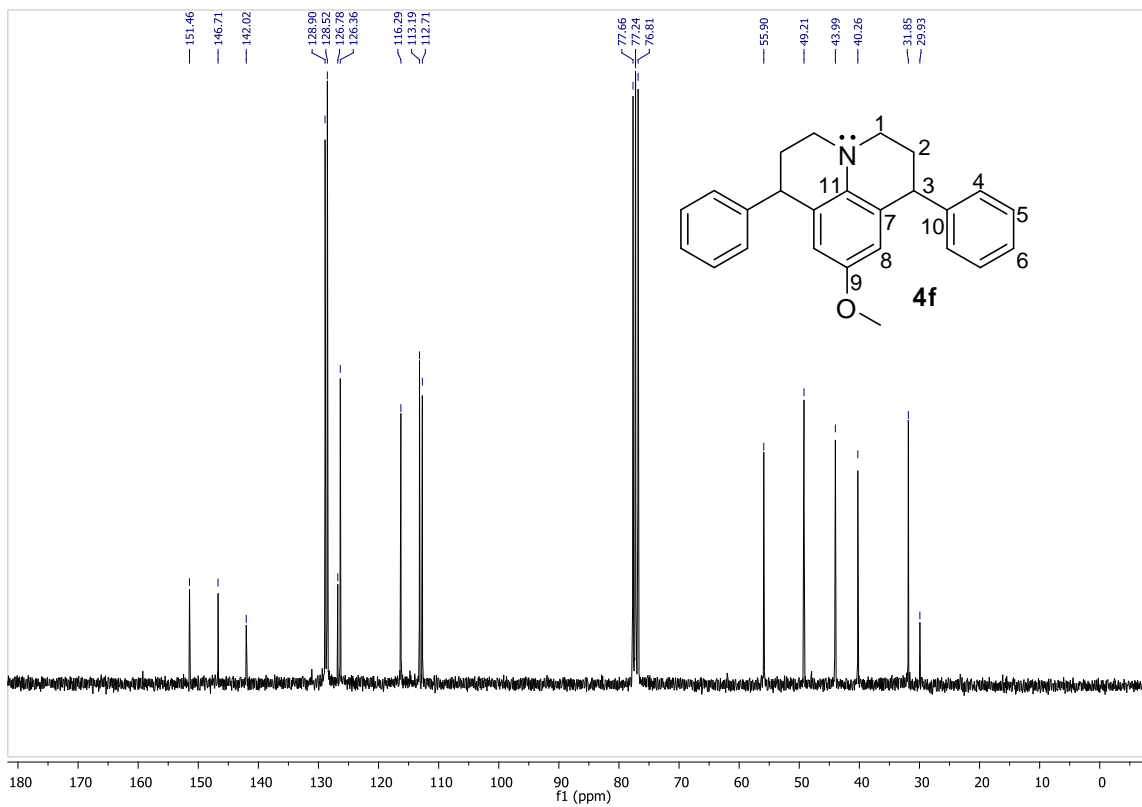
¹H NMR (300 MHz, CDCl₃) of **4e**.



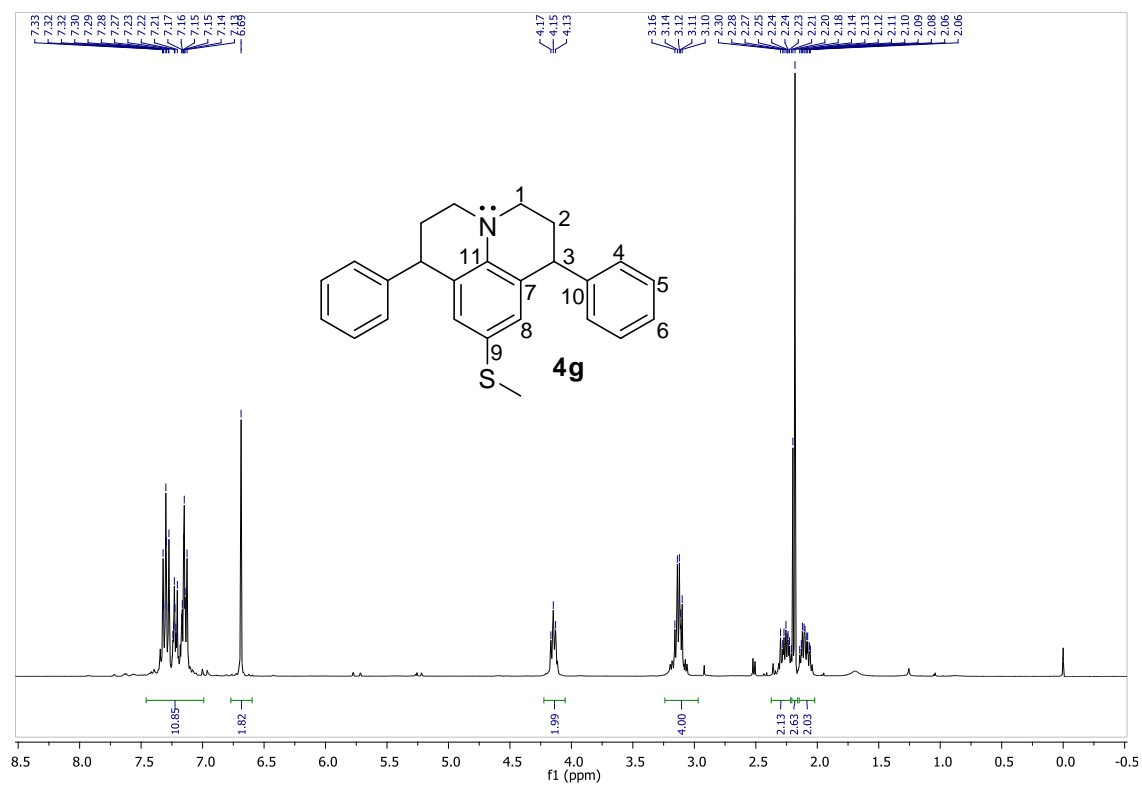
¹³C NMR (75 MHz, CDCl₃) of **4e**.



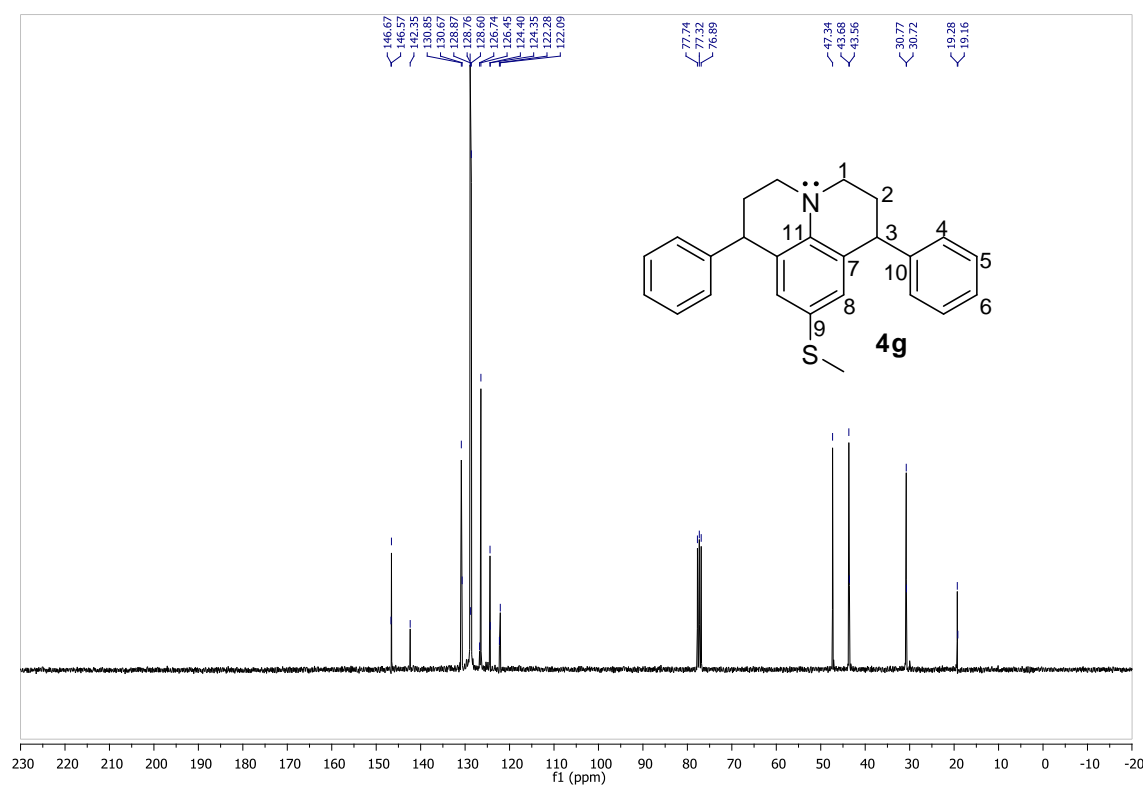
NMR (300 MHz, CDCl₃) of **4f**.



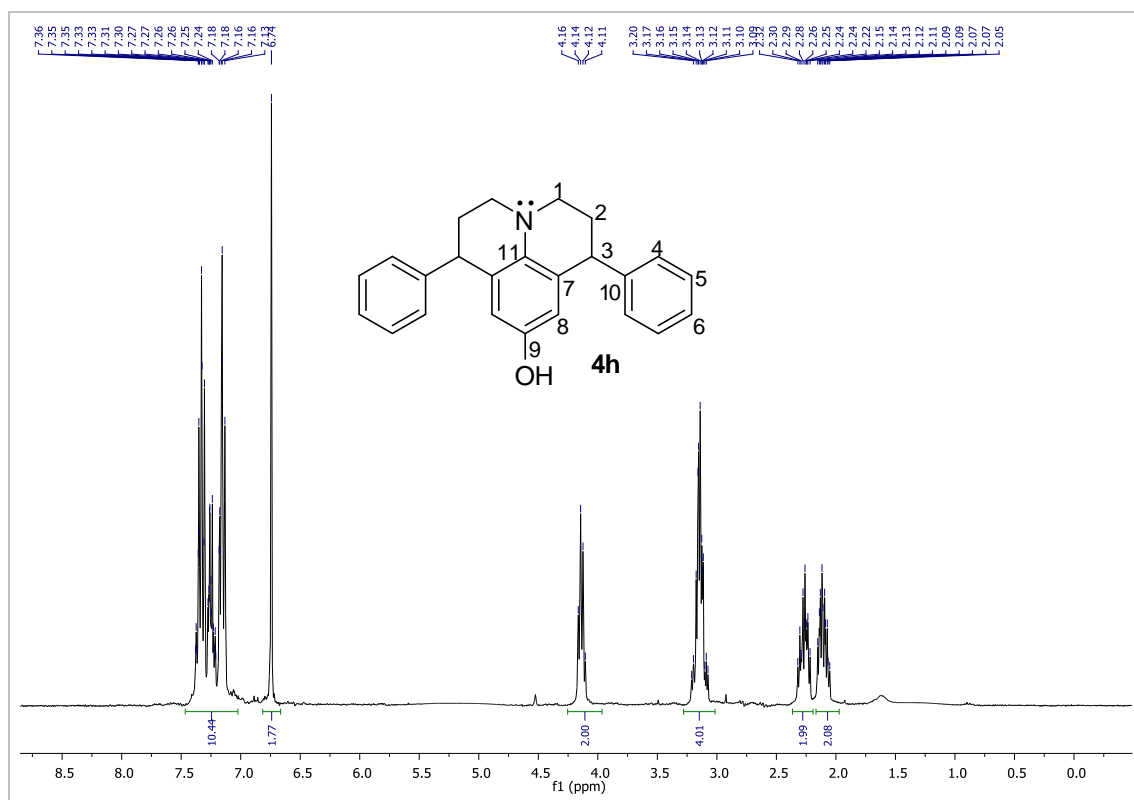
¹³C NMR (75 MHz, CDCl₃) of **4f**.



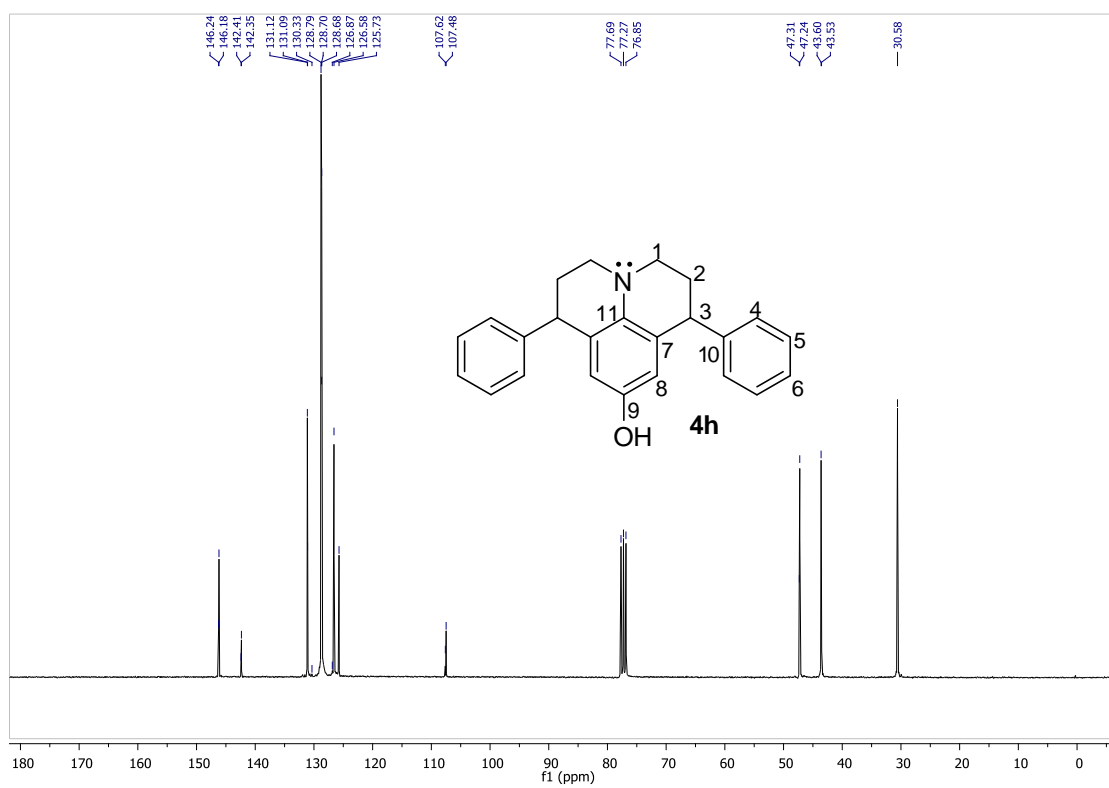
¹H NMR (300 MHz, CDCl₃) of **4g**.



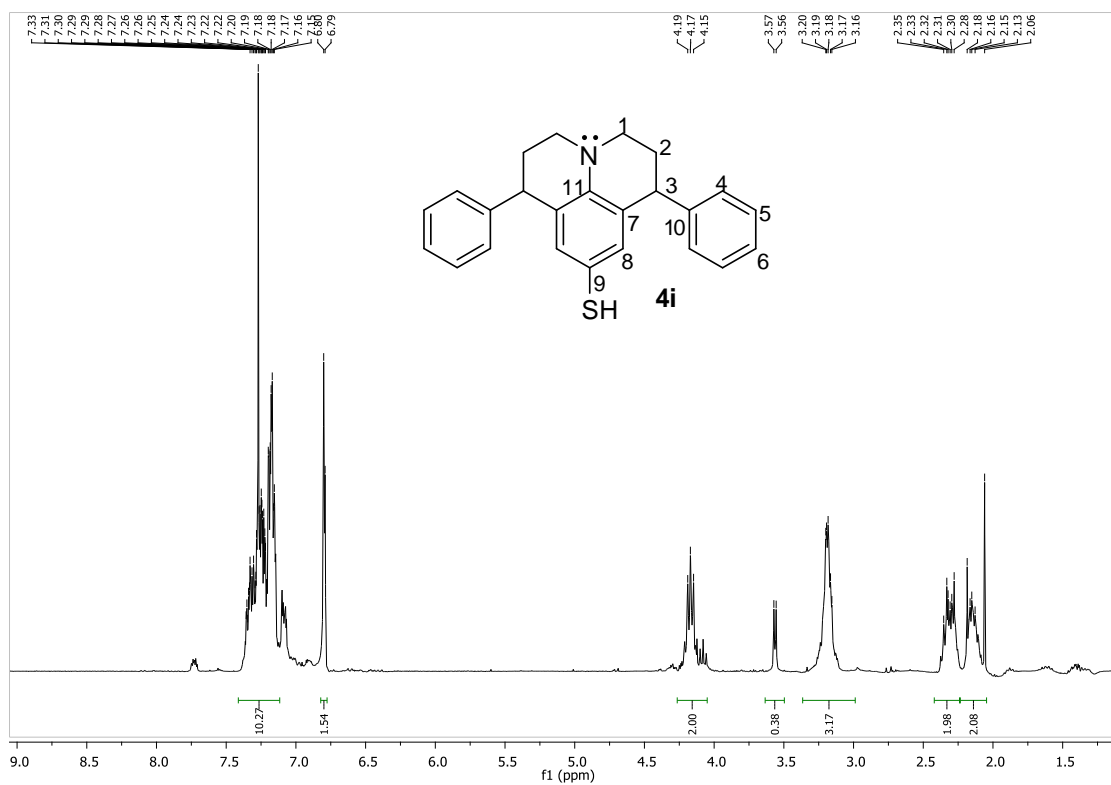
¹³C NMR (75 MHz, CDCl₃) of **4g**.



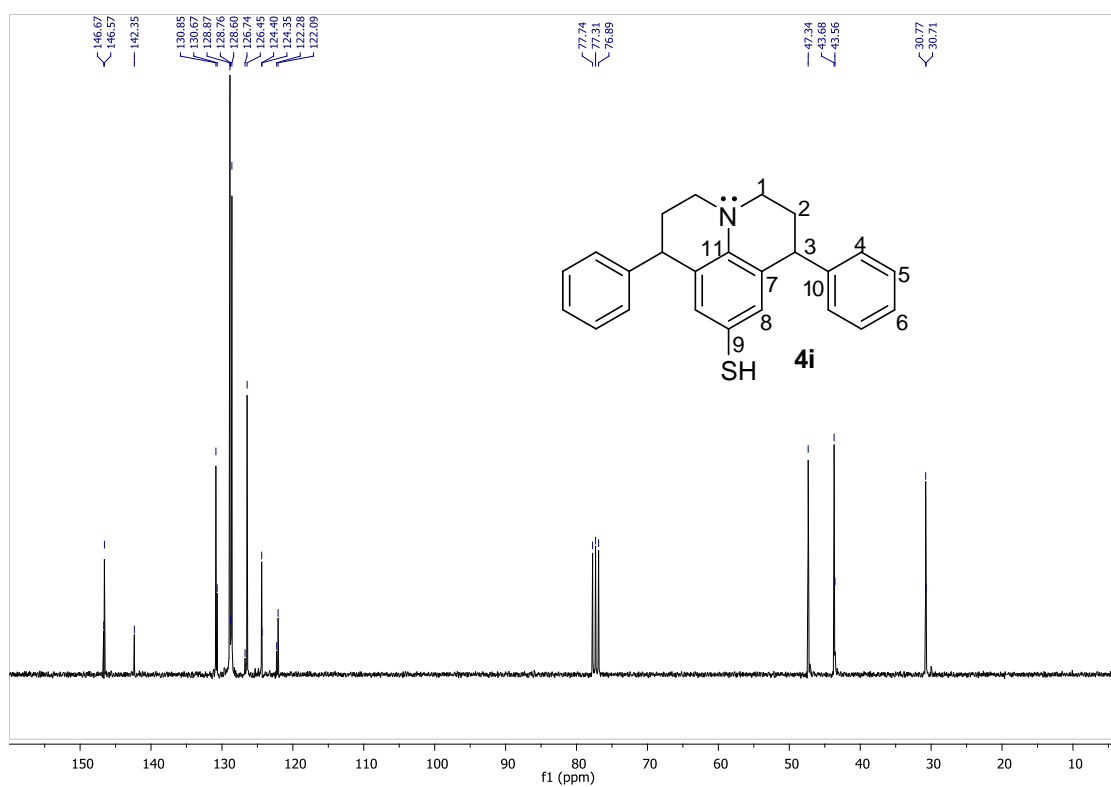
¹H NMR (300 MHz, CDCl₃) of **4h**.



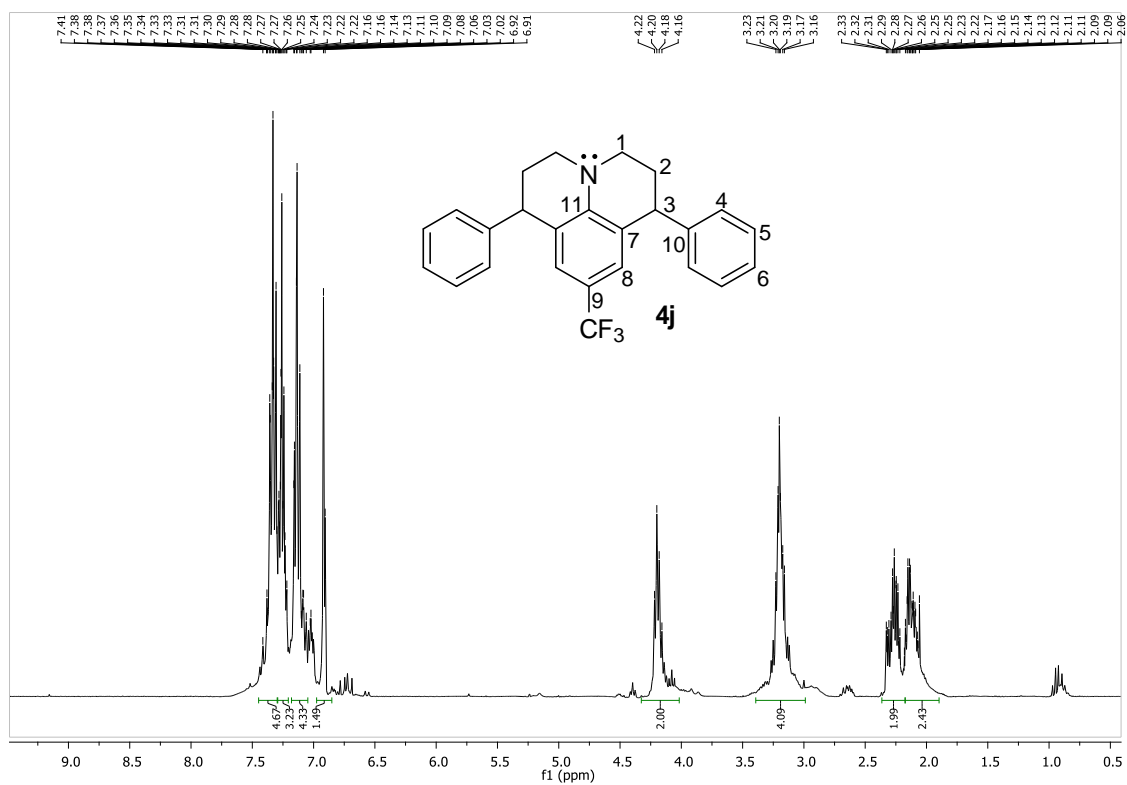
¹³C NMR (75 MHz, CDCl₃) of **4h**.



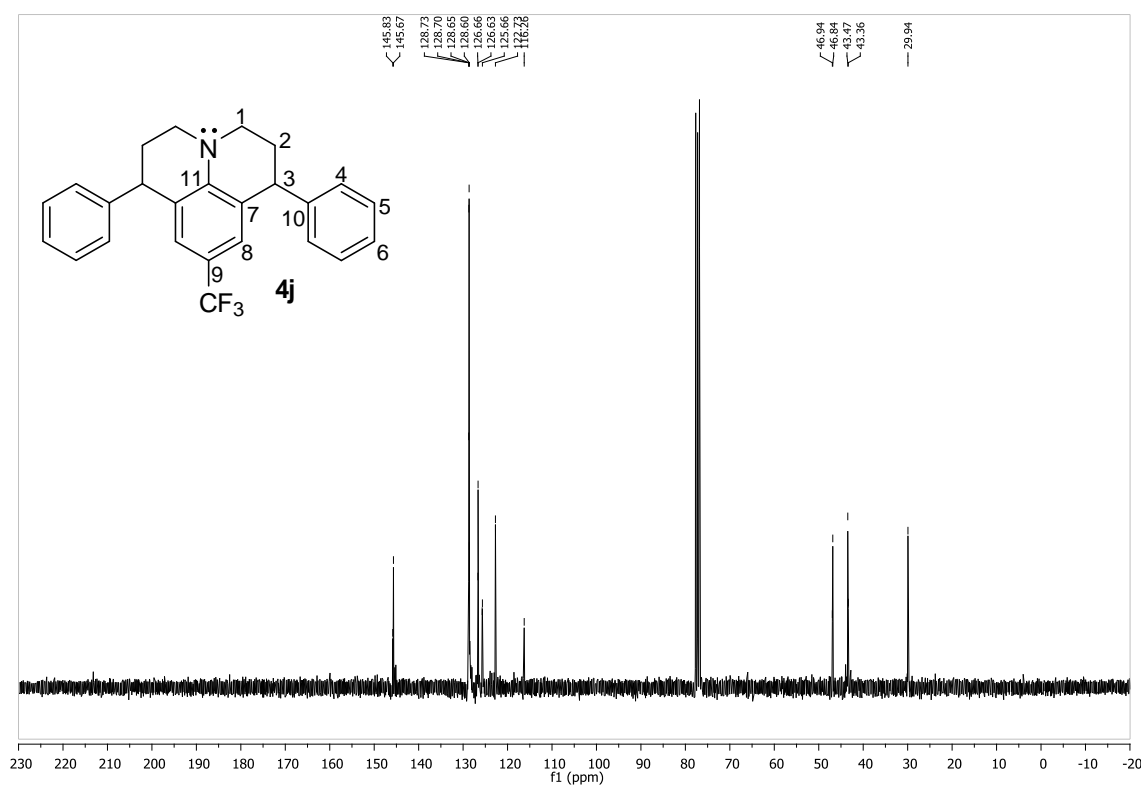
¹H NMR (300 MHz, CDCl₃) of 4i.



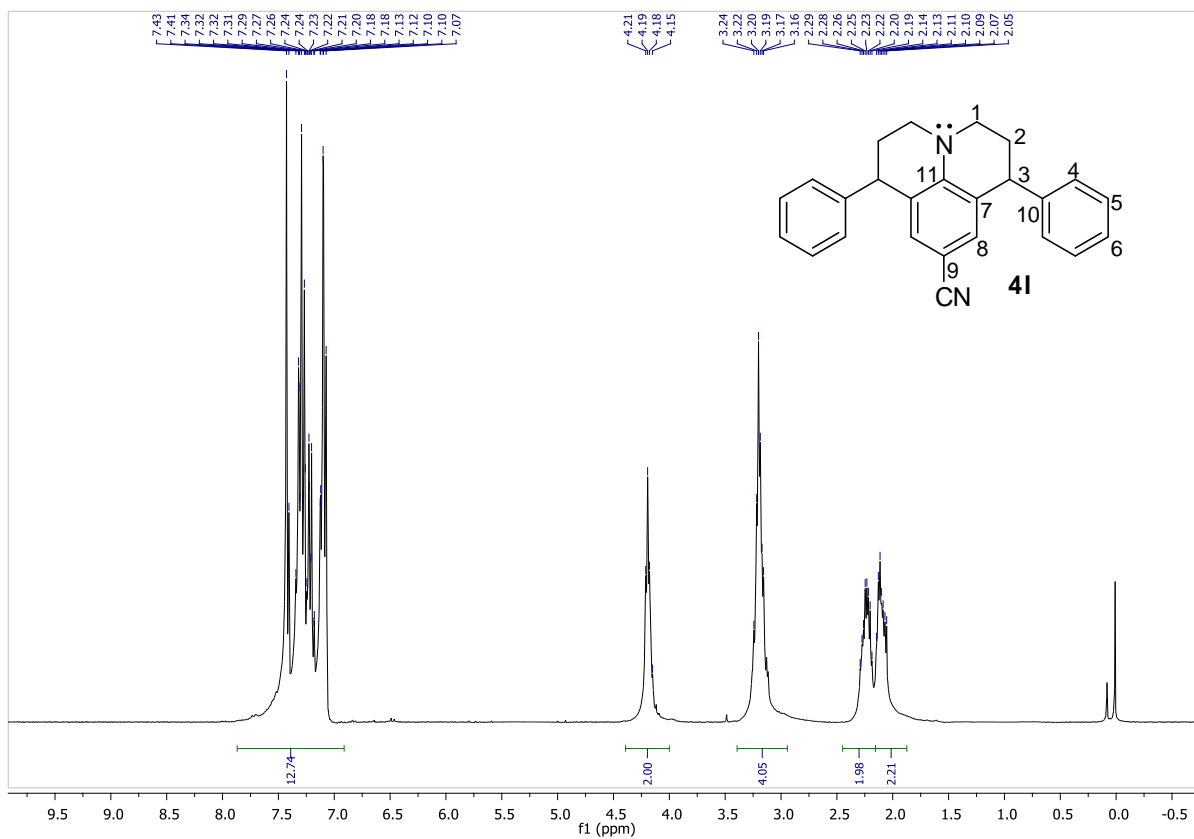
¹³C NMR (75 MHz, CDCl₃) of 4i.



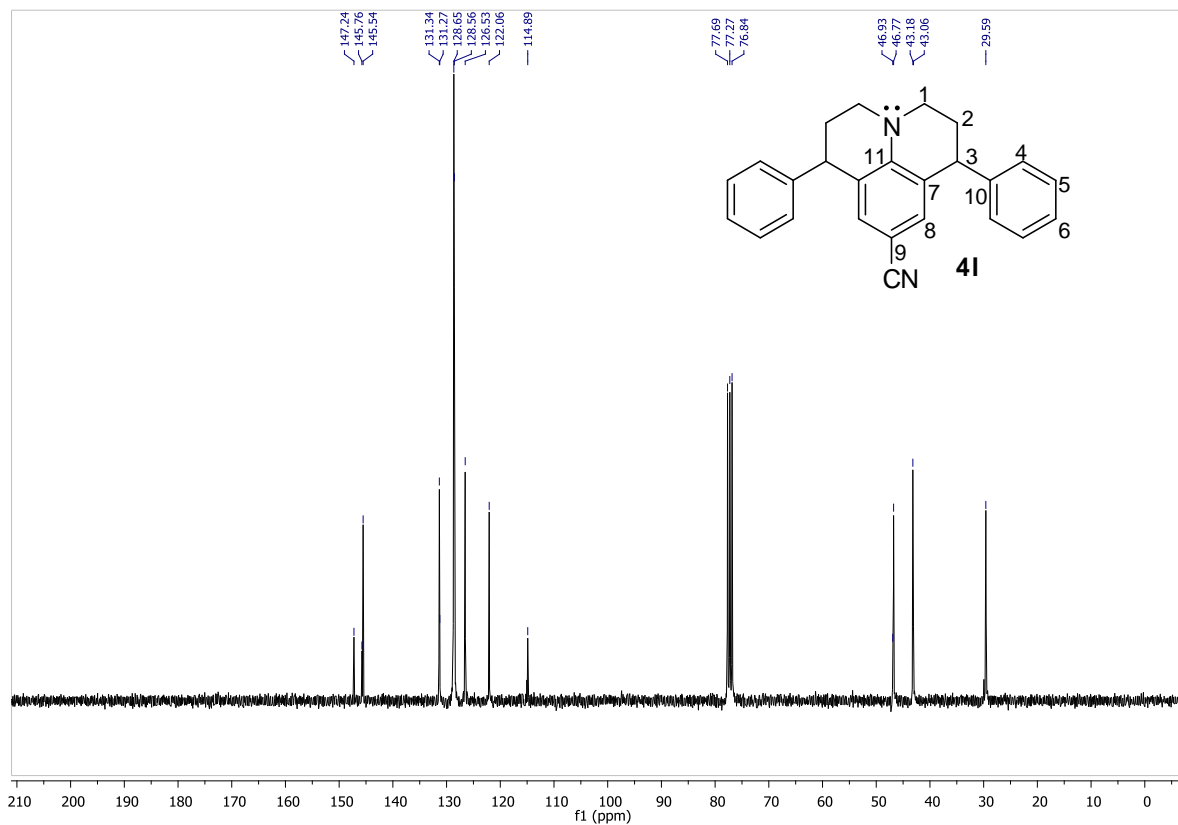
¹H NMR (300 MHz, CDCl₃) of **4j**.



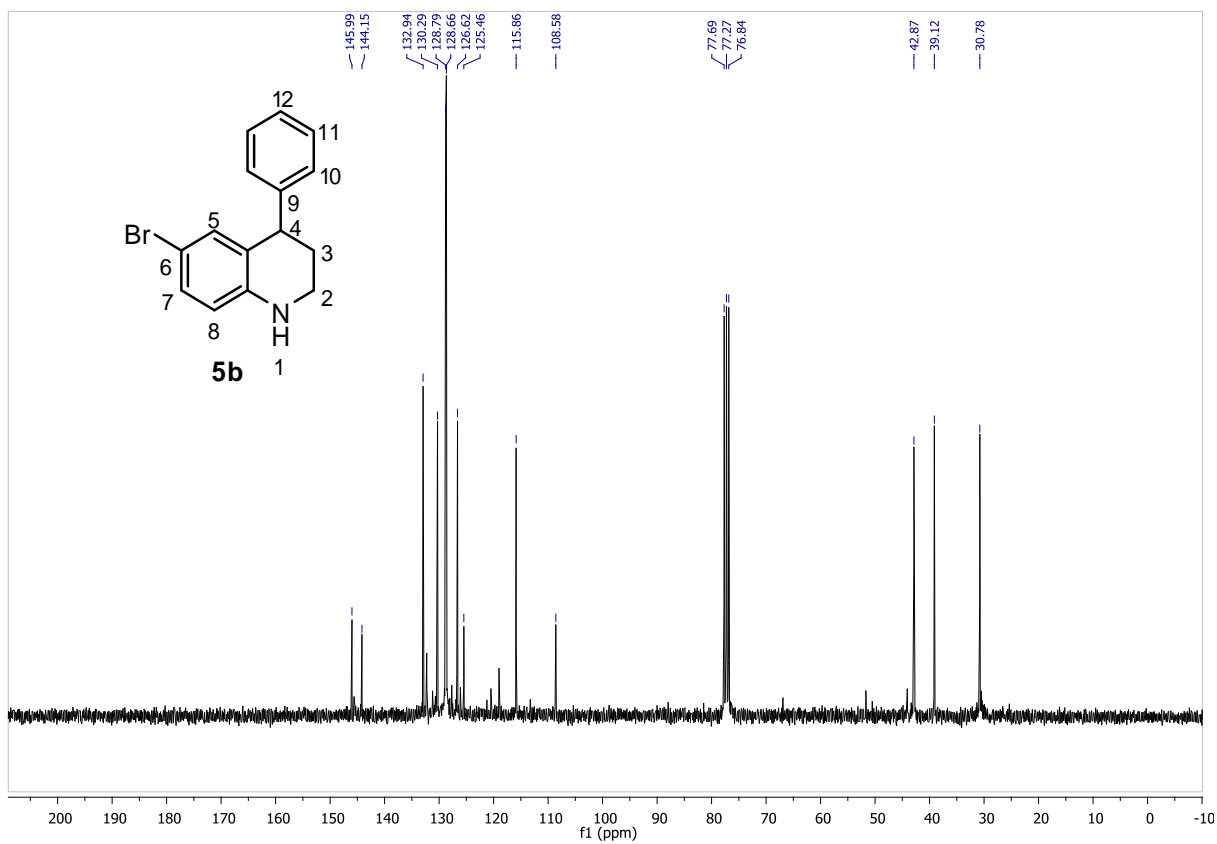
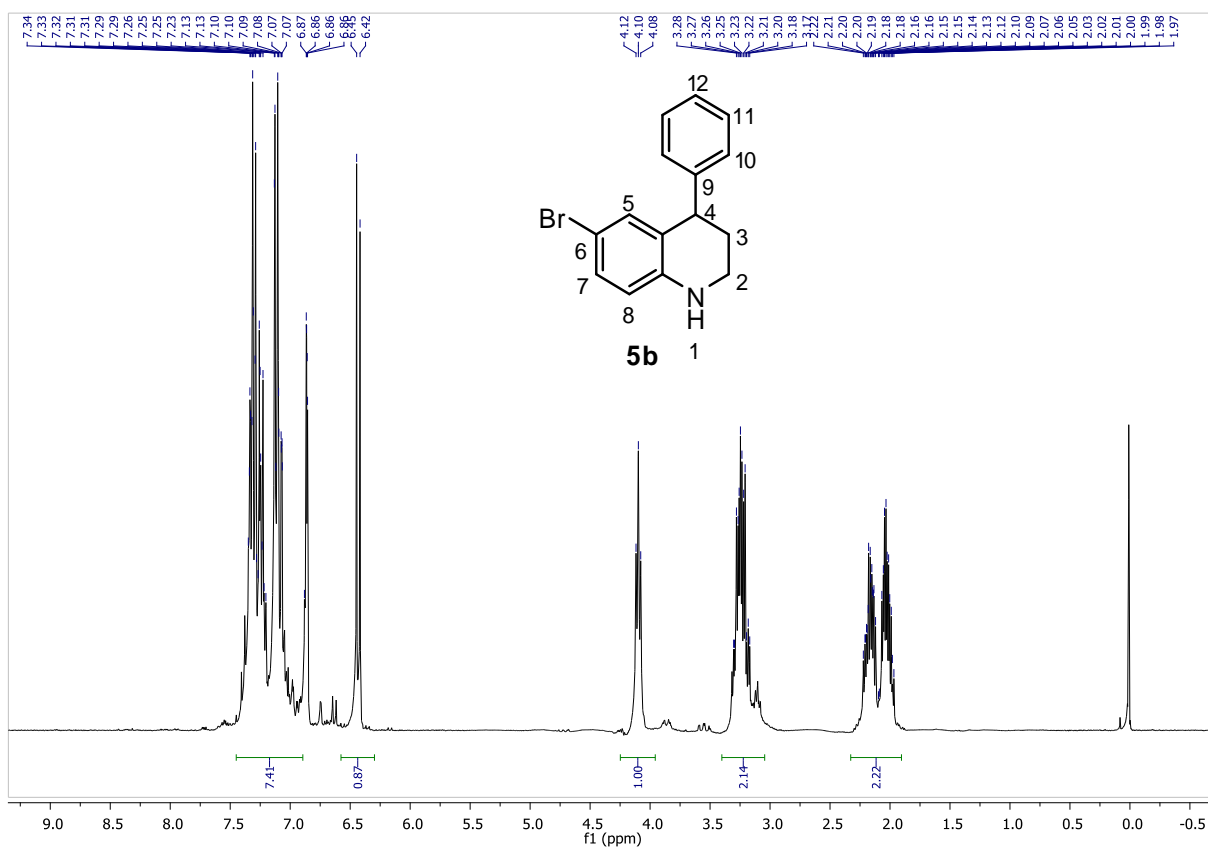
¹³C NMR (75 MHz, CDCl₃) of **4j**.

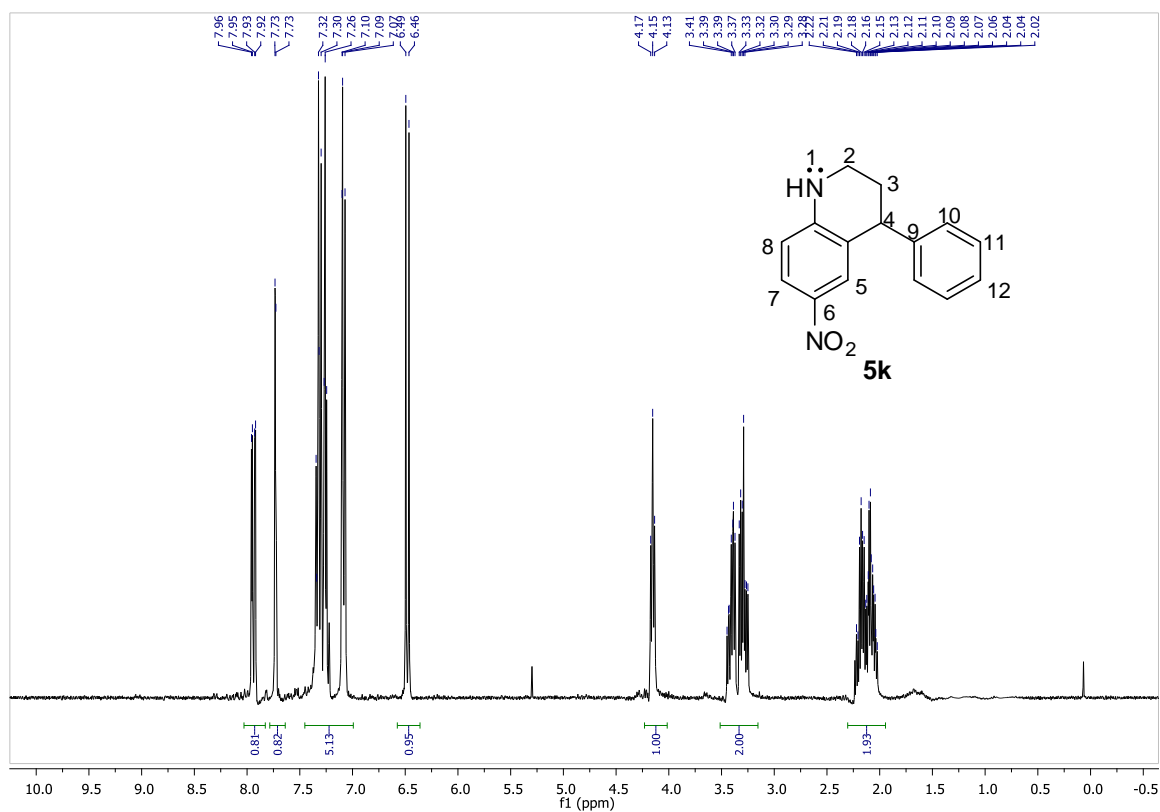


¹H NMR (300 MHz, CDCl₃) of **4I**.

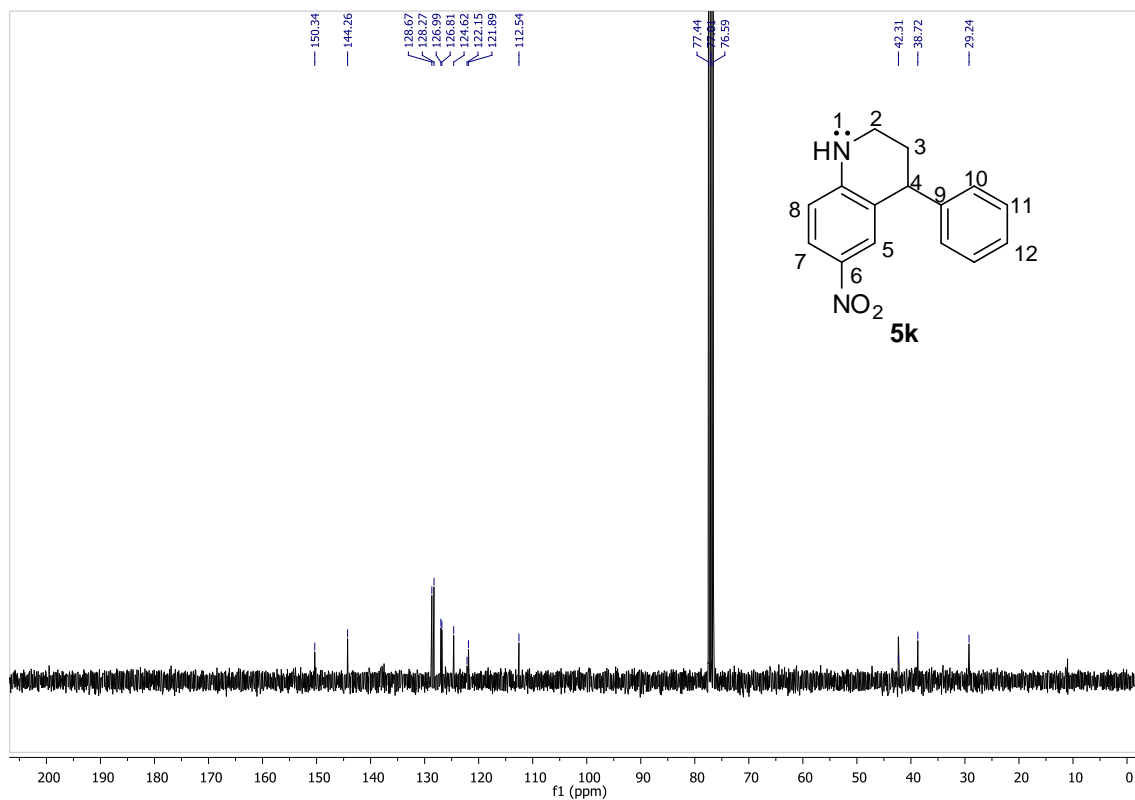


¹³C NMR (75 MHz, CDCl₃) of **4I**.

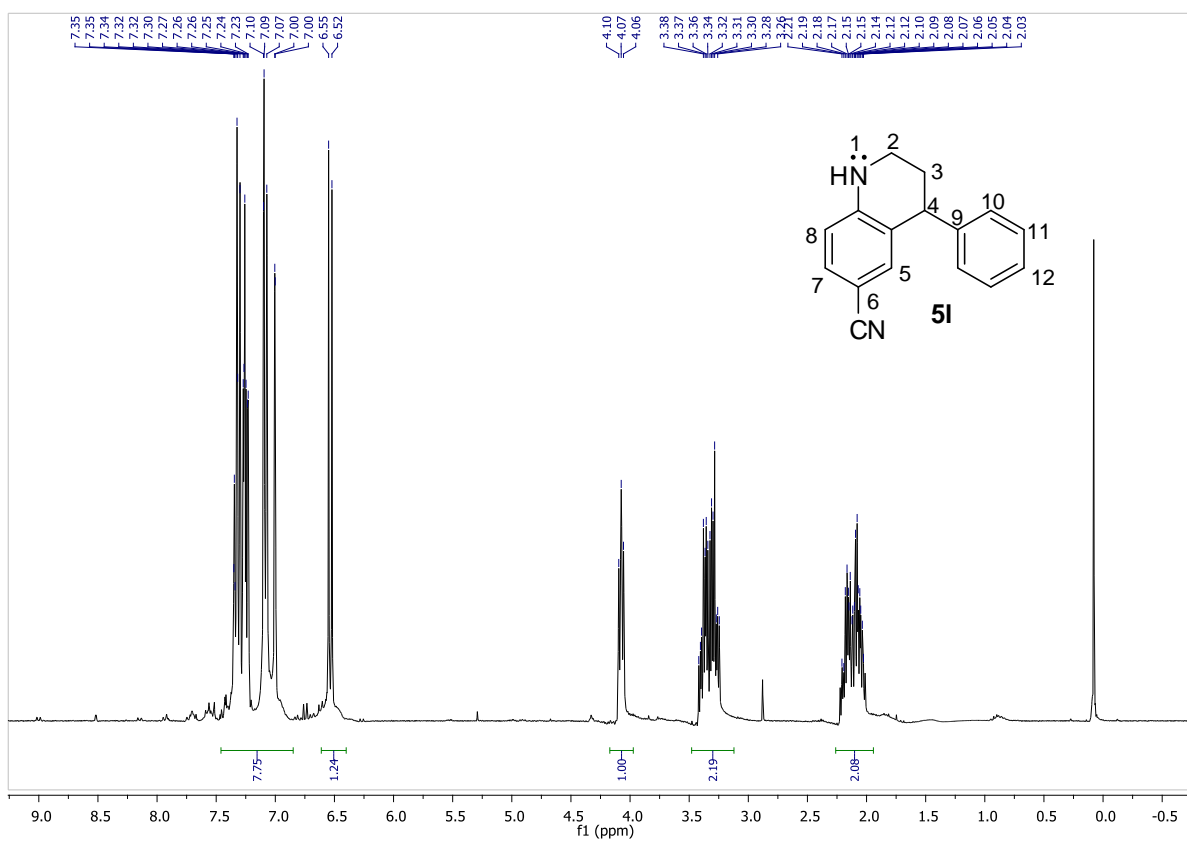




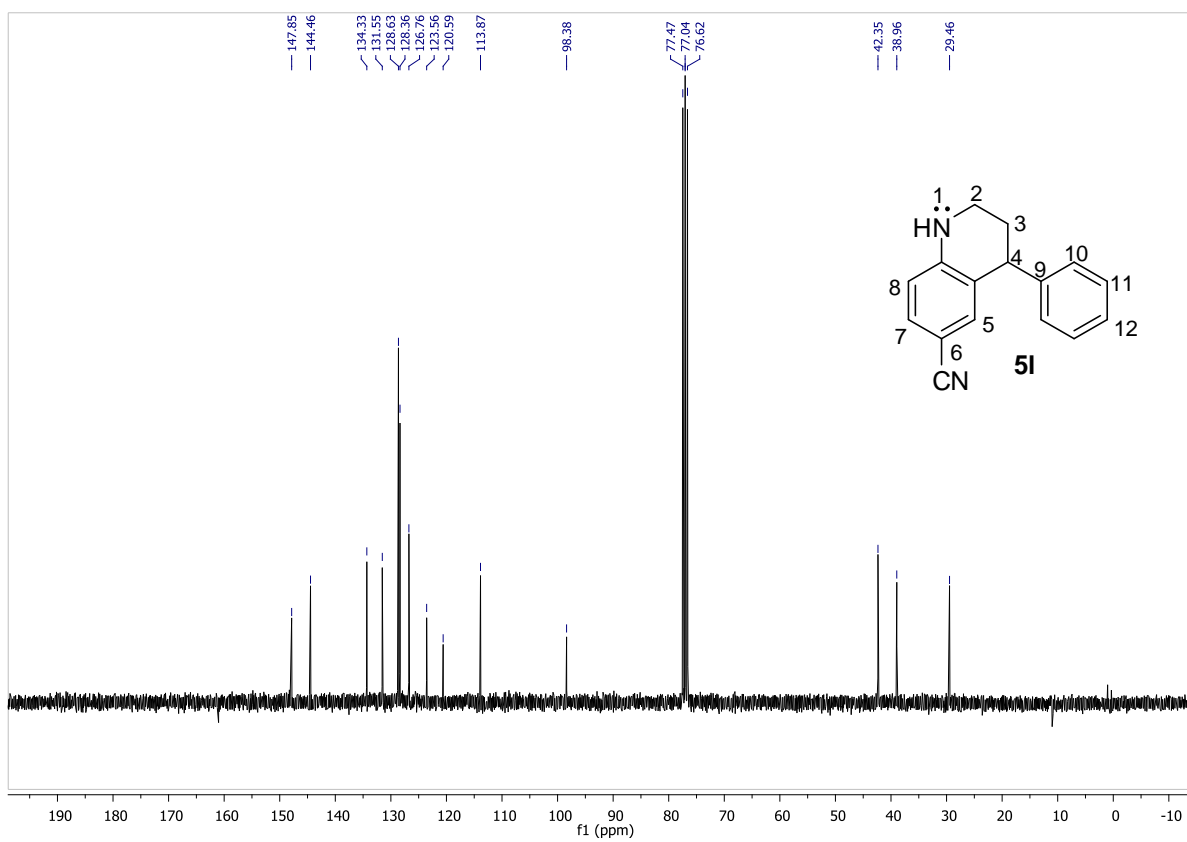
¹H NMR (300 MHz, CDCl₃) of **5k**.



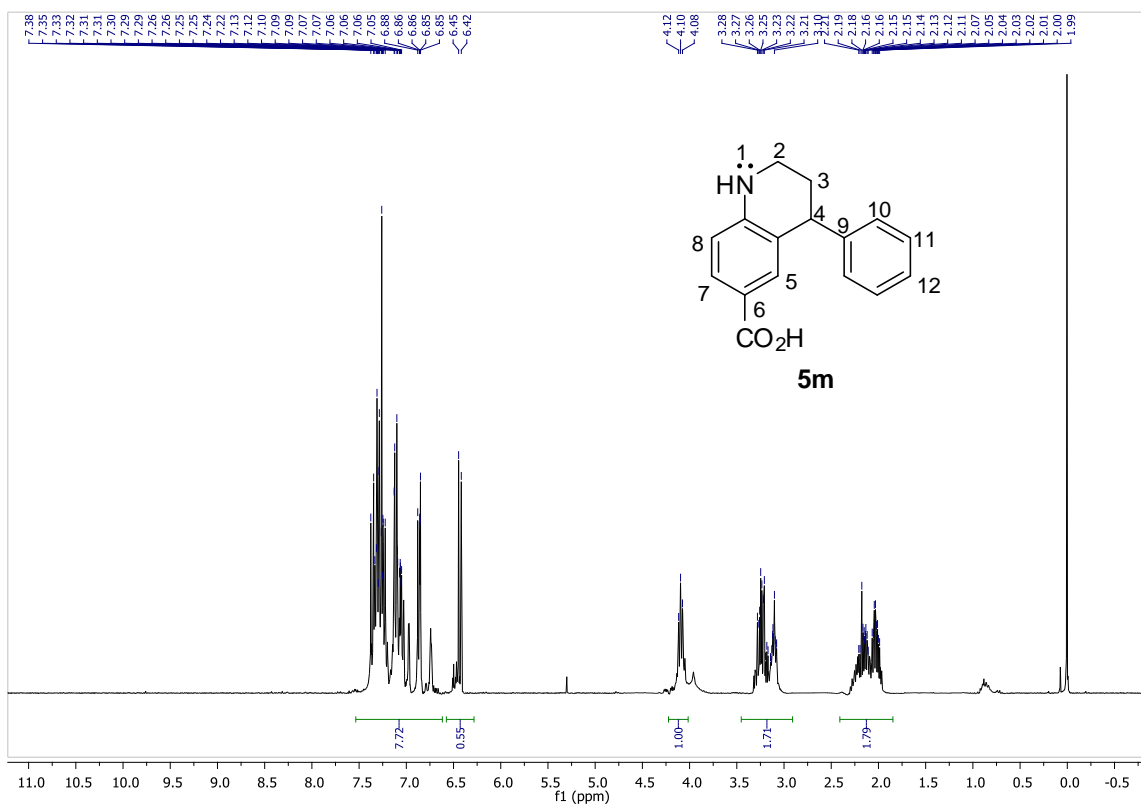
¹³C NMR (75 MHz, CDCl₃) of **5k**.



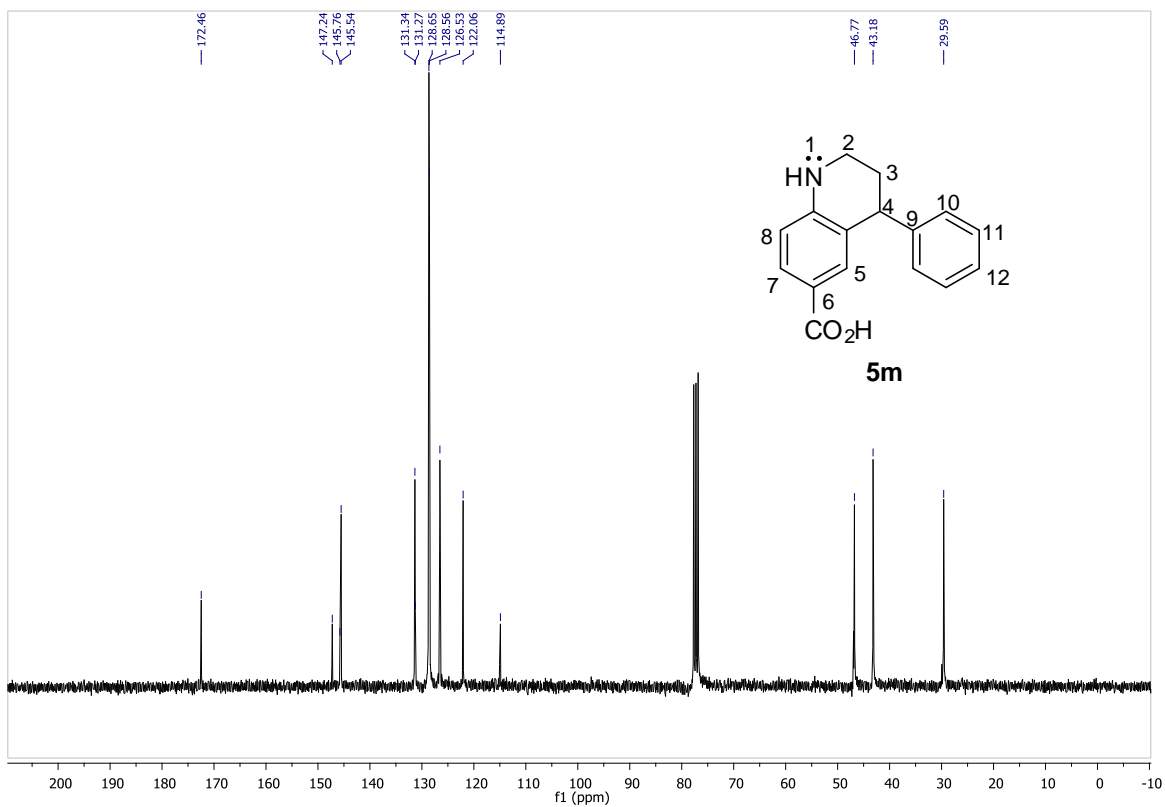
¹H NMR (300 MHz, CDCl₃) of **5I**.



¹³C NMR (75 MHz, CDCl₃) of **5I**.

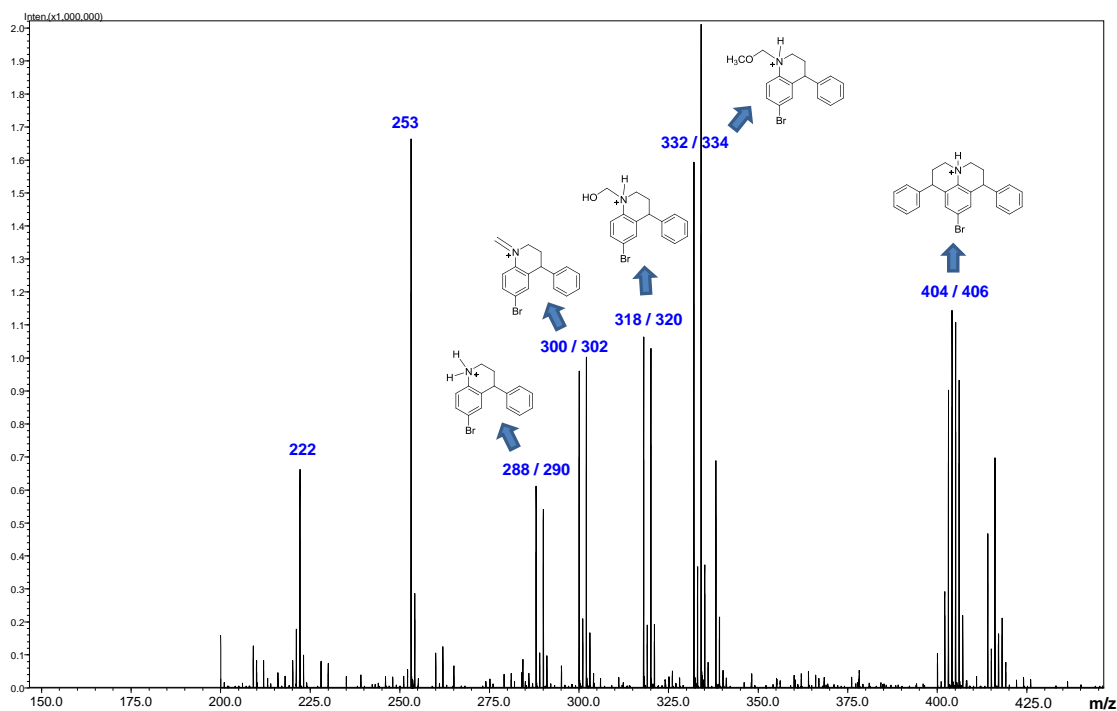


¹H NMR (300 MHz, CDCl₃) of 5m.

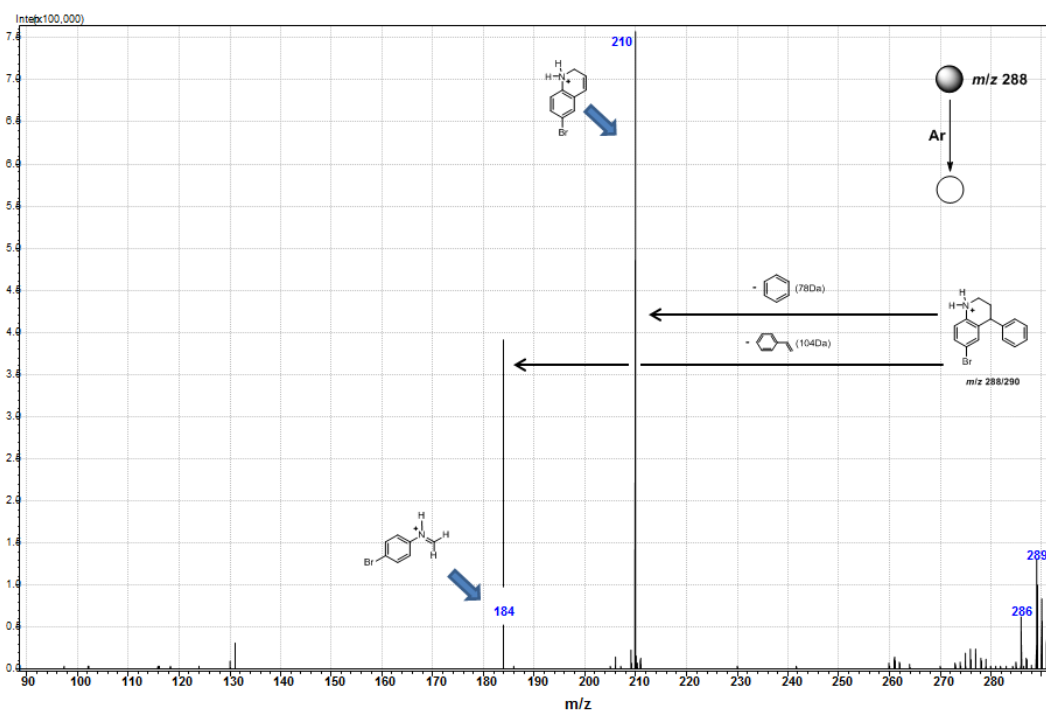


¹³C NMR (75 MHz, CDCl₃) of 5m.

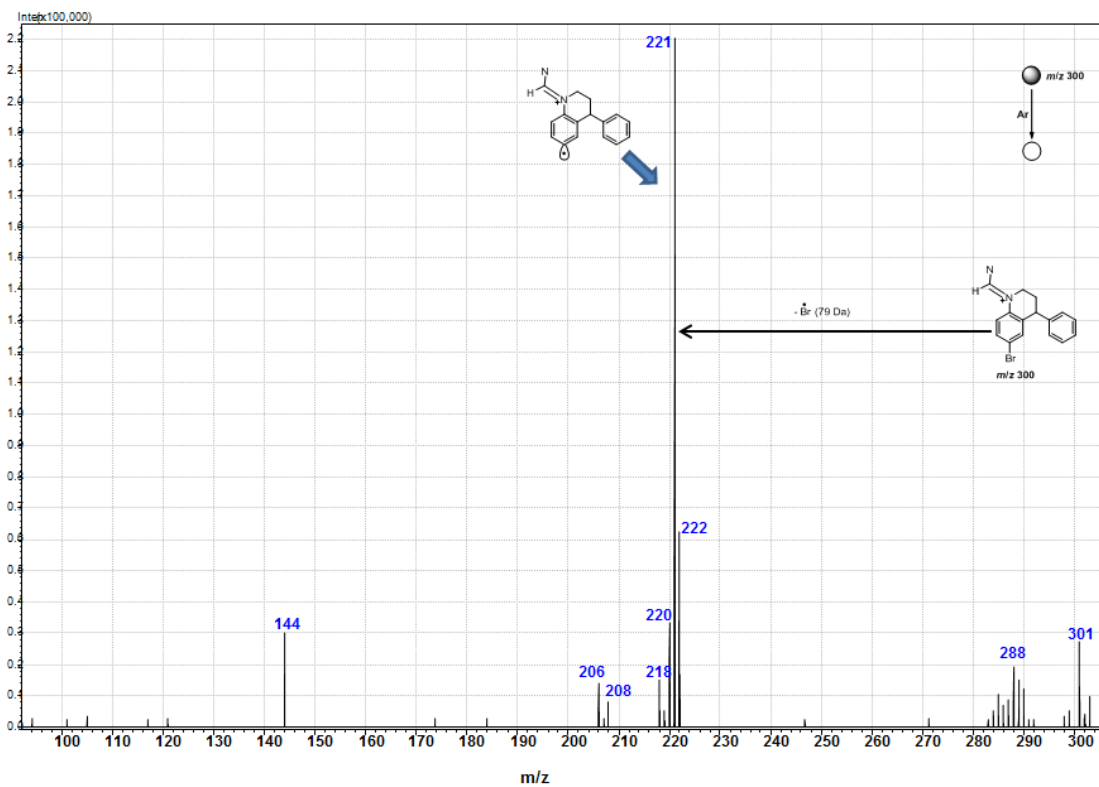
ESI-MS and ESI-MS/MS spectra from monitoring reaction of 4-bromoaniline, formaldehyde, styrene and *p*-sulfonic acid calix[4]arene.



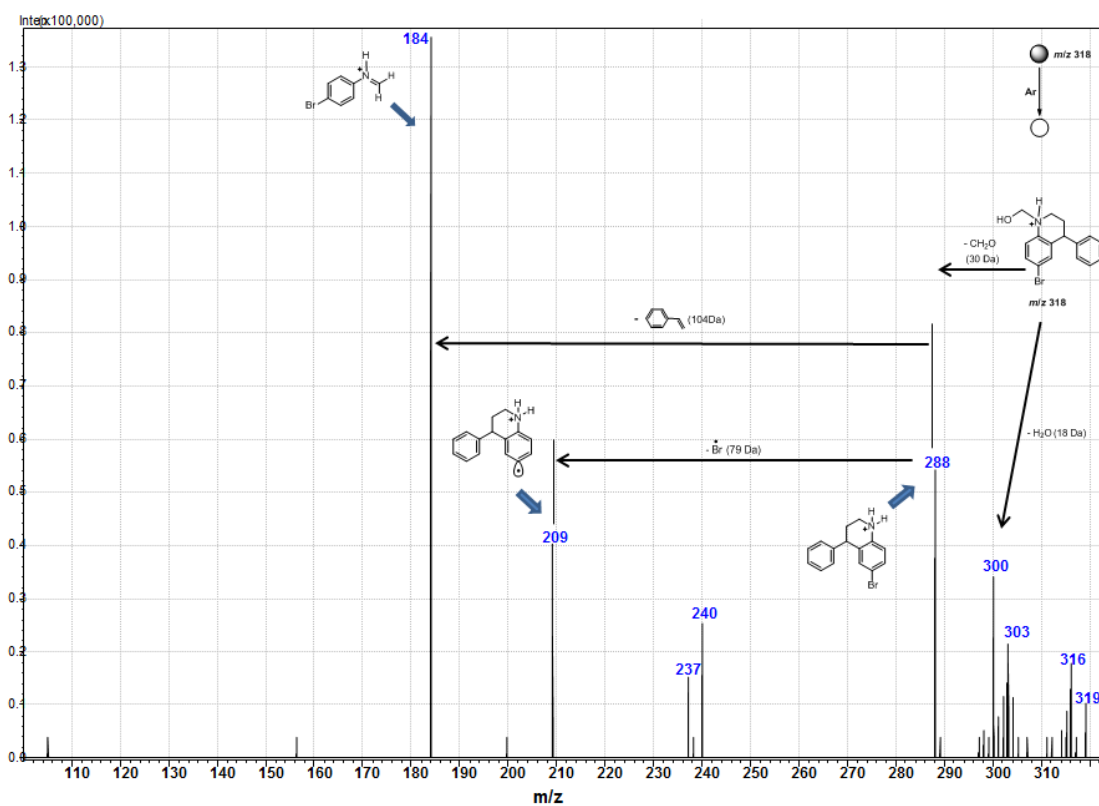
ESI(+)-MS spectrum of three component Povarov reaction between 4-bromoaniline, formaldehyde and styrene, after 30 min, for the formation of Julolidine **4b**.



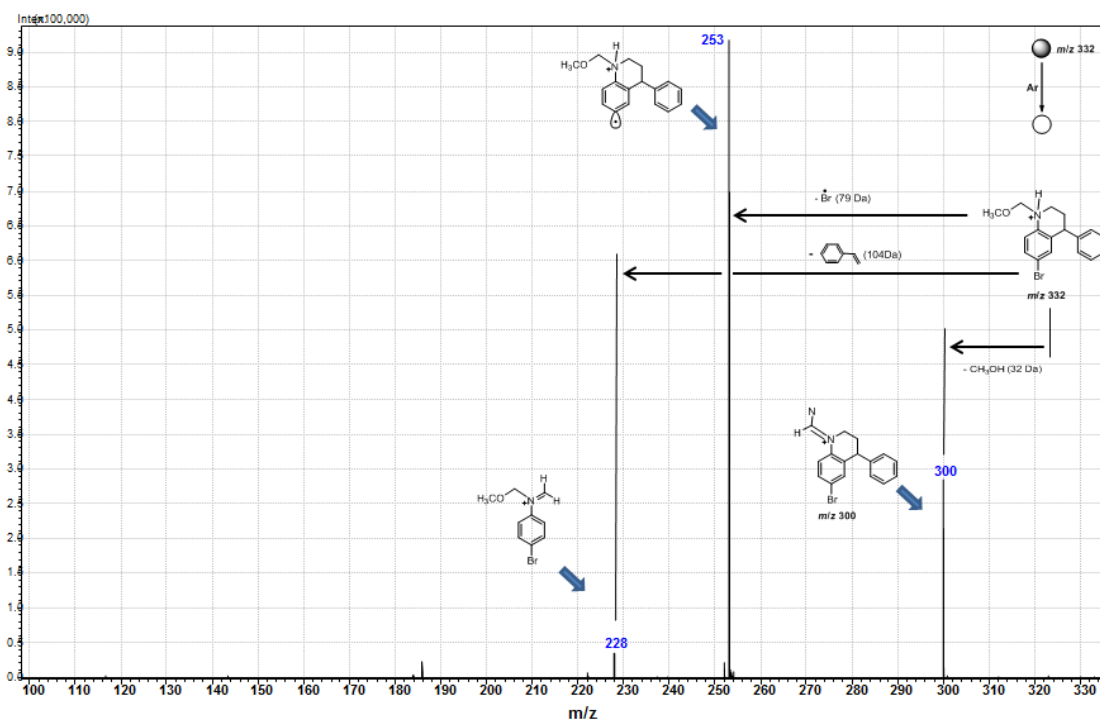
ESI(+)-MS/MS spectrum of selected ion m/z 288.



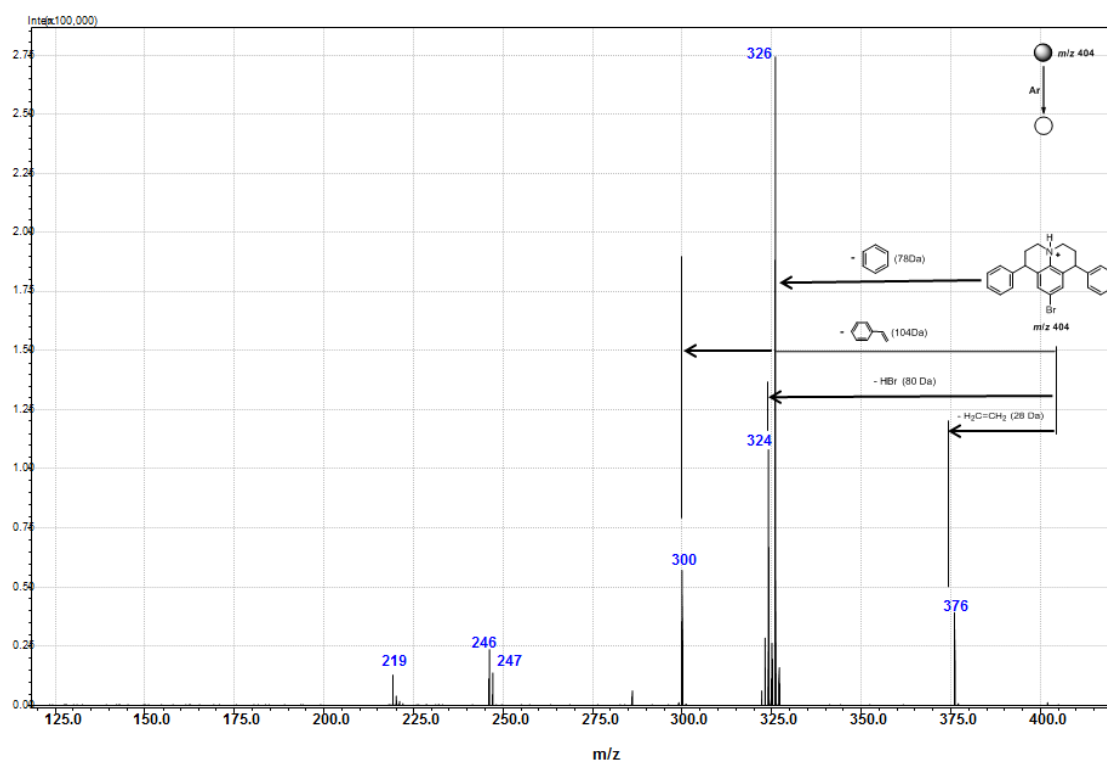
ESI(+)-MS/MS spectrum of selected ion m/z 300.



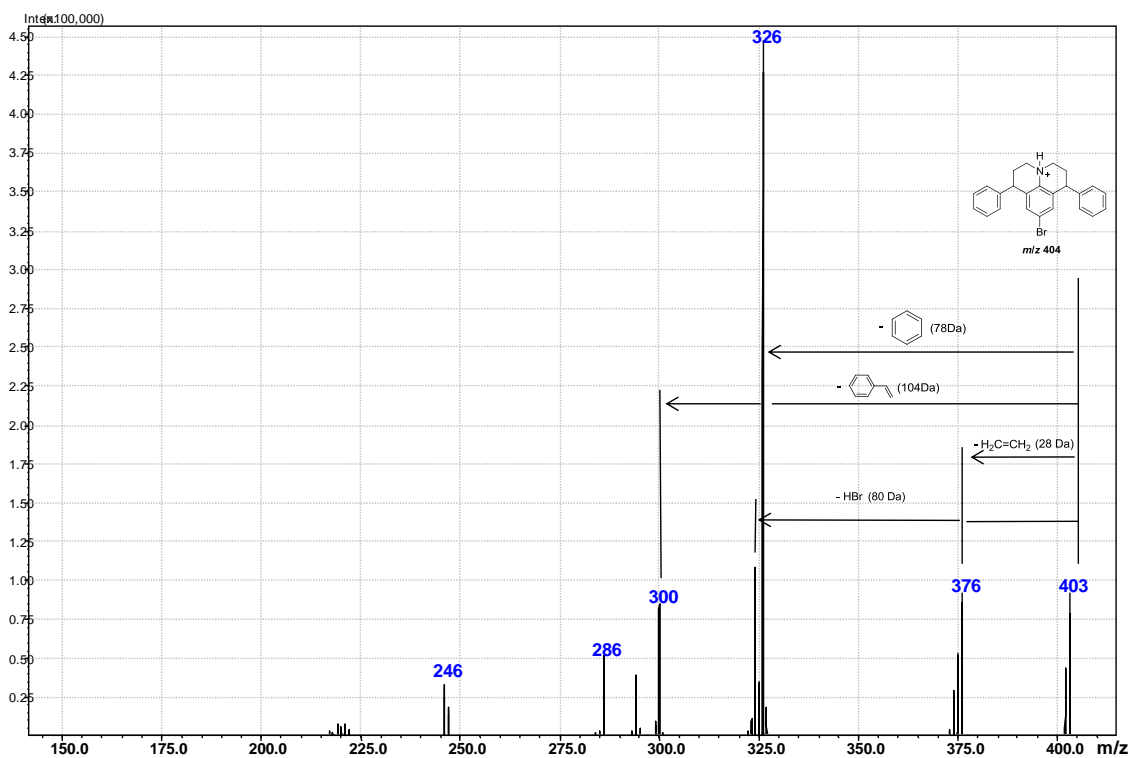
ESI(+)-MS/MS spectrum of selected ion m/z 318.



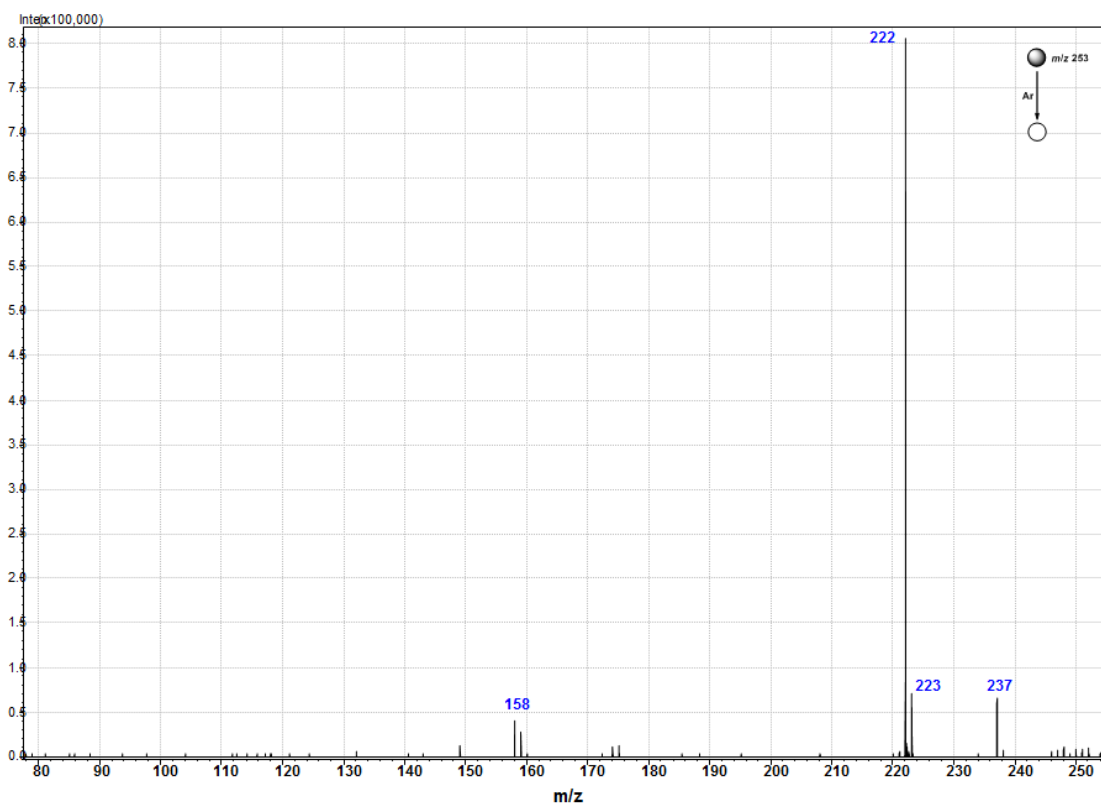
ESI(+)-MS/MS spectrum of selected ion m/z 332.



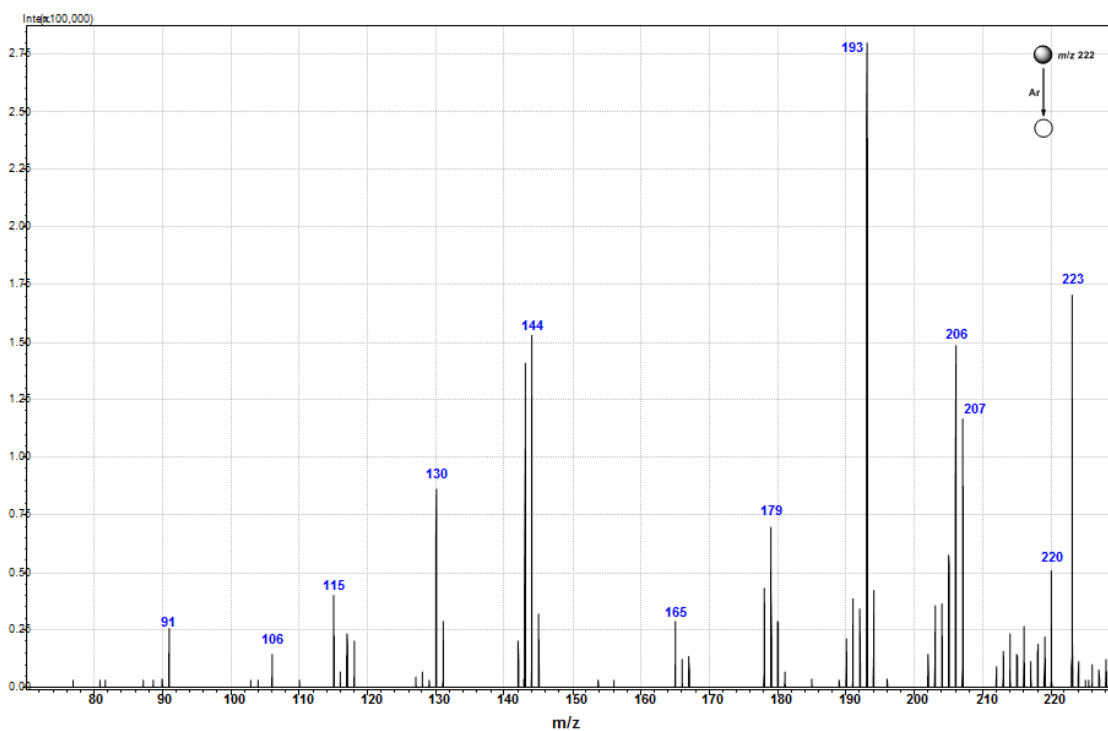
ESI(+)-MS/MS spectrum of selected ion m/z 404.



ESI(+)-MS/MS spectrum of selected ion m/z 404 from reaction between **5b**, formaldehyde and styrene, after 24hours.

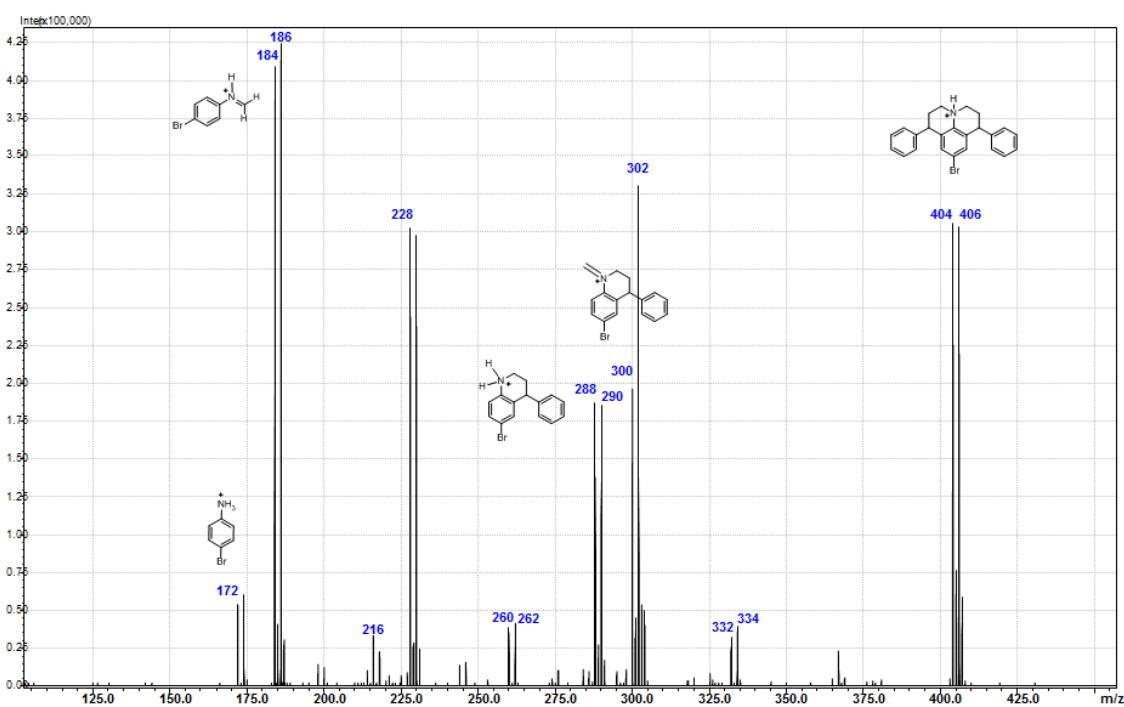


ESI(+)-MS/MS spectrum of selected ion m/z 253.

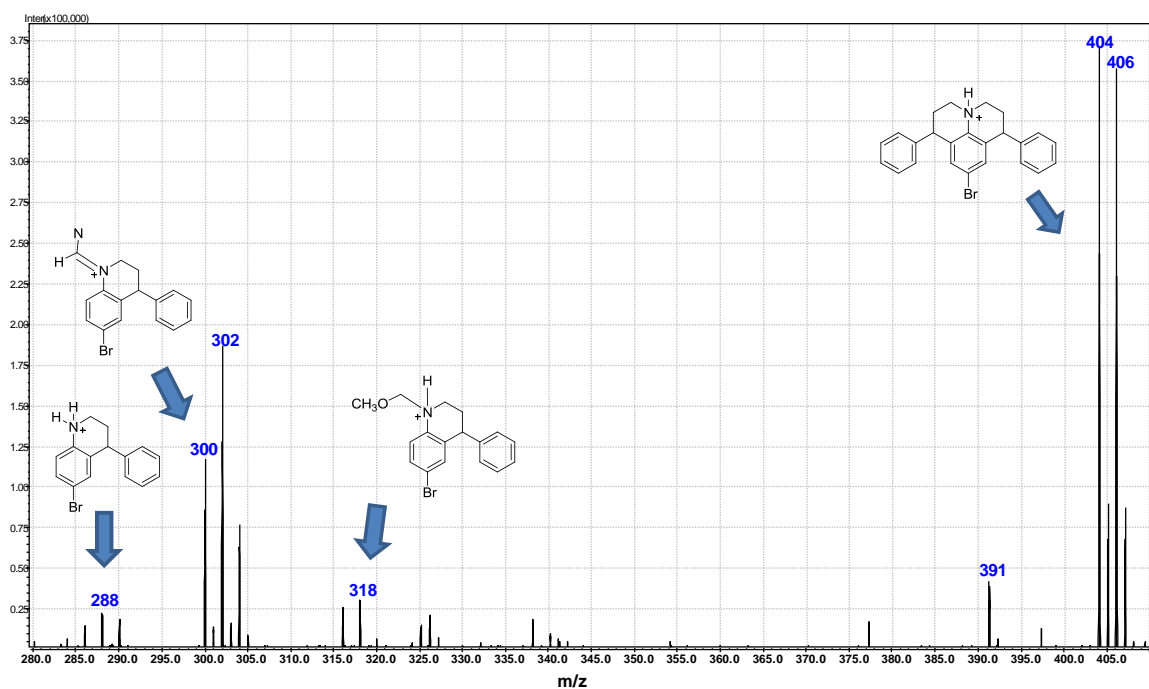


ESI(+)-MS/MS spectrum of selected ion m/z 222.

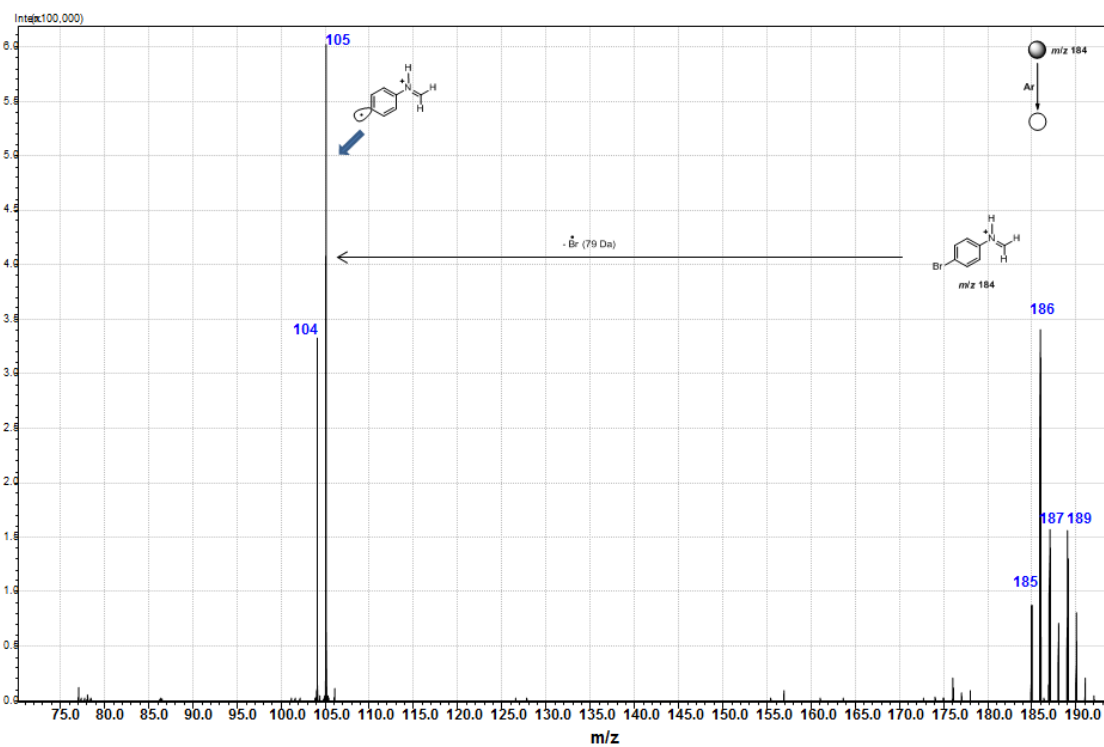
APCI-MS and APCI-MS/MS spectra from monitoring reaction of 4-bromoaniline, formaldehyde, styrene and *p*-sulfonic acid calix[4]arene.



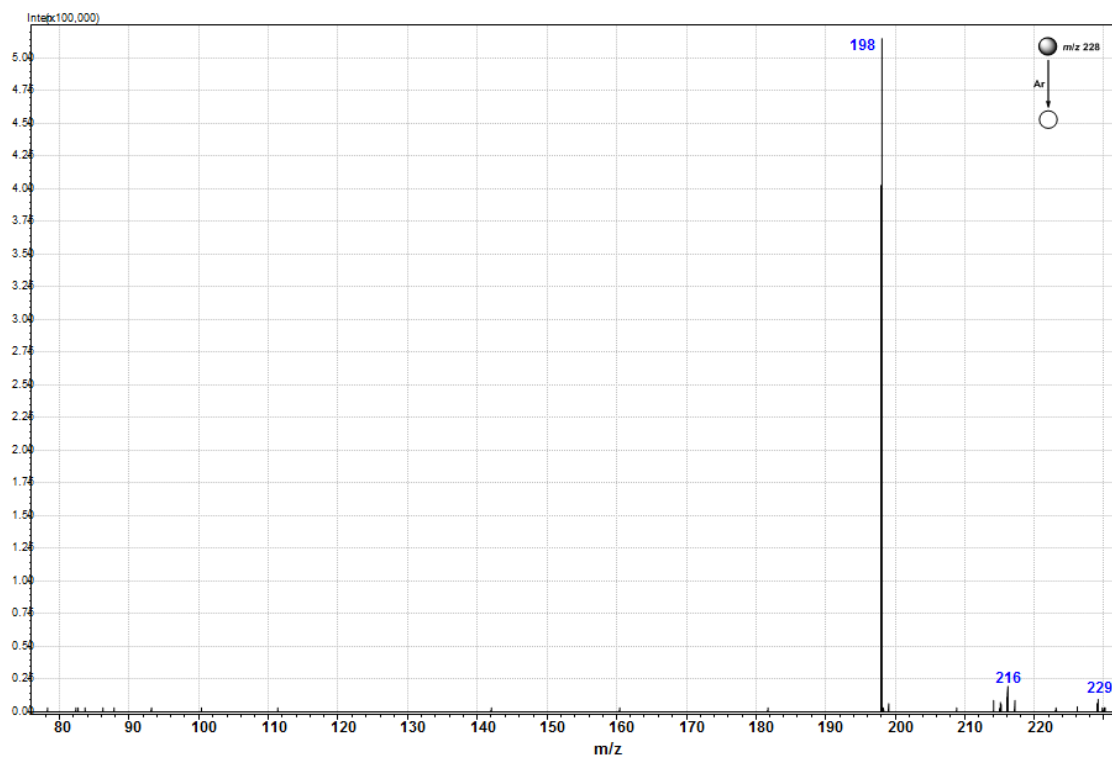
APCI(+)-MS spectrum of three component Povarov reaction between 4-bromoaniline, formaldehyde and styrene, after 30 min, for the formation of Julolidine **4b**.



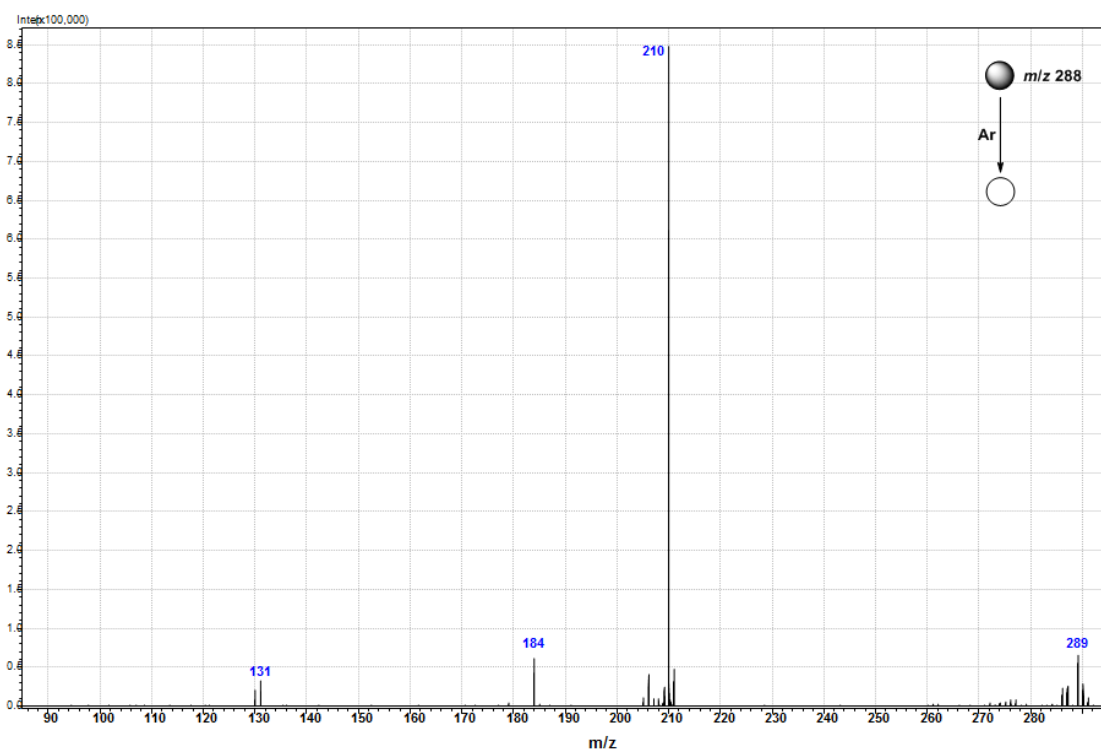
APCI(+)-MS spectrum of the reaction between isolated compound **5b**, formaldehyde and styrene, after 24 hours.



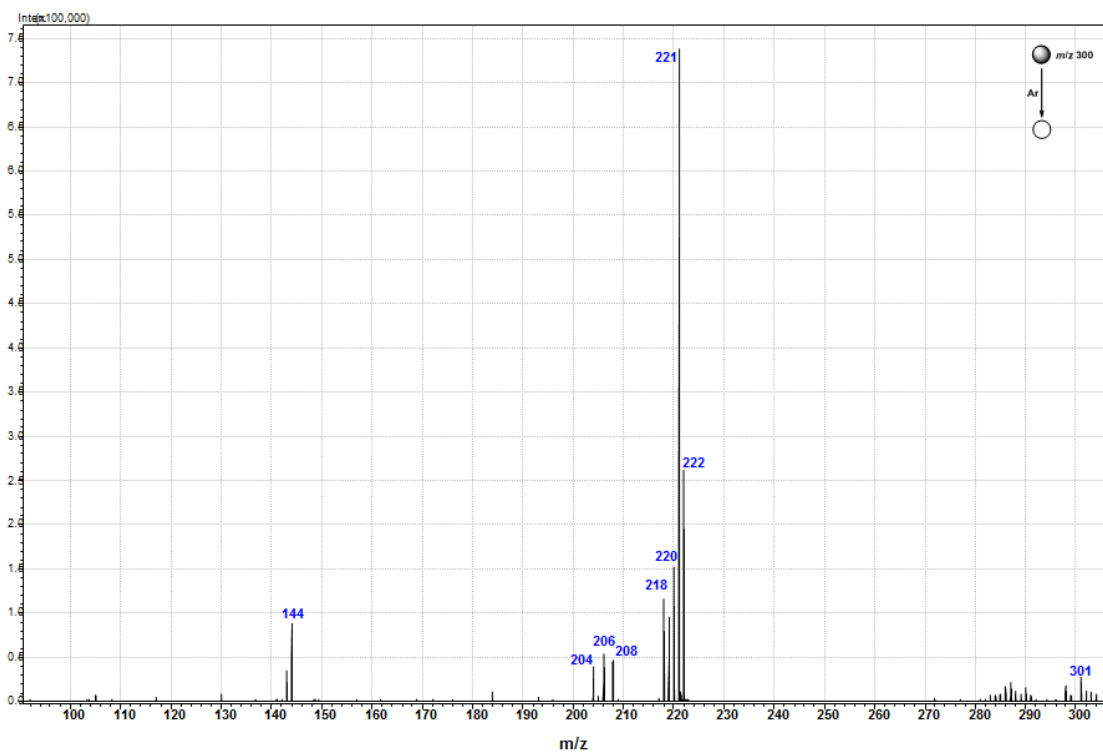
APCI(+)-MS/MS spectrum of selected ion m/z 184.



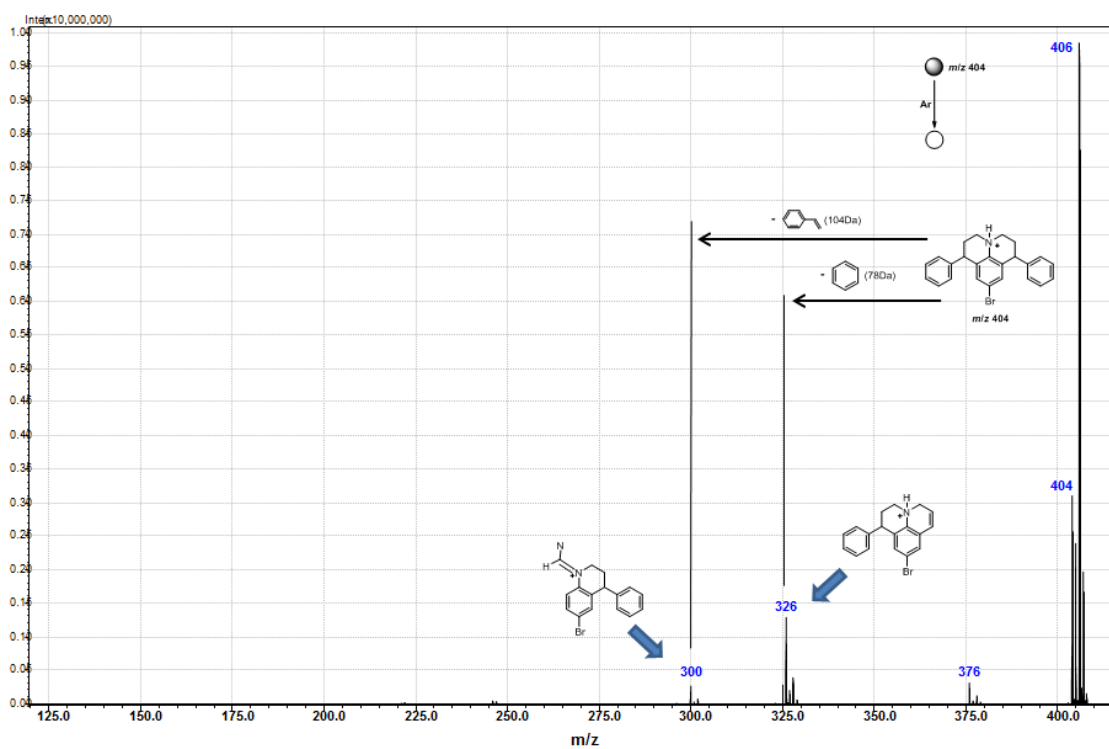
APCI(+)-MS/MS spectrum of selected ion m/z 228.



APCI(+)-MS/MS spectrum of selected ion m/z 288.



APCI(+)-MS/MS spectrum of selected ion m/z 300.



APCI(+)-MS/MS spectrum of selected ion m/z 404.

DETERMINATION OF THE DIASTEREOMERIC EXCESS

Determination of the diastereomeric excess (*de*) was used GC/MS, and possible integration of the signals corresponding to the two diastereoisomers. Julolidine **4b** was selected as representative compound. Figure S1 represents the typical chromatogram obtained and integration of the peaks.

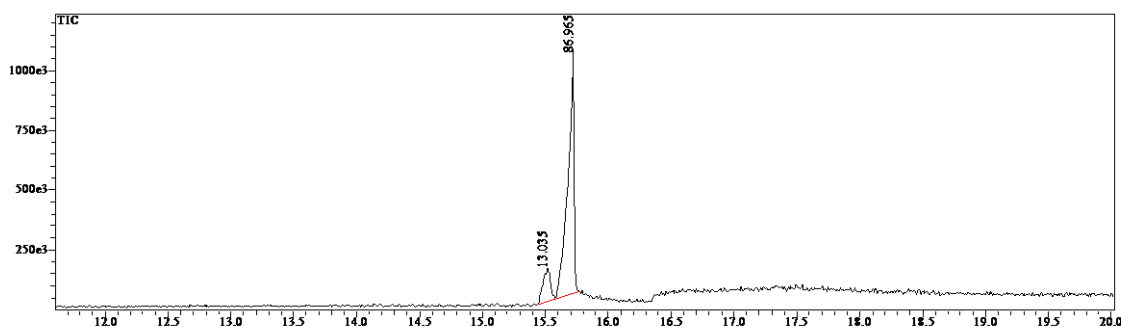


Figure S1 – Chromatogram GC/MS for julolidine **4b** reaction employed with *p*-sulfonic calix[4]arene as catalyst.

DETERMINATION OF THE MAJOR DIASTEREOMER.

Julolidine **4b** was selected as representative compound. The relative stereochemistry of the two asymmetric carbons has been determined by means of NMR spectroscopy. Full assignment of the ^1H and ^{13}C spectra was achieved by bi-dimensional experiments (HETCOR and COSY). A detailed analysis of the ^1H NMR spectrum, in particular of the signals corresponding to **H-2 α** and **H-2 β** , revealed that both their signals exhibit a large coupling constant ($J_{3,2}=6.0$ Hz for **H-2 α** and $J_{3,2}=12.0$ Hz for **H-2 β**) with one of the diastereotopic hydrogens of **C-3**. This indicates that both **H-2 α** and **H-2 β** are in a pseudo-axial position on the julolidine ring, having a *trans*-diaxial relationship with one of the hydrogens belonging to **C-2**.⁴ NOEDiff experiments were acquired in order to confirm the relative stereochemistry. On saturation of the hydrogen **H-3** in the pseudo-axial position in face α of ring, and the phenyl ring in pseudo-equatorial position in face β of ring (trace a, in Figure S2), NOE enhancement is observable only for **H-2 β** . On saturation of **H-3** (trace b), a large NOE is observed on **H-2 β** , thus confirming the 1,3-diaxial proximity of **H-3** and **H-2 β** already deduced from the analysis of the proton spectrum. NMR analysis proves that the relative configuration is therefore *cis*. The relative configuration of the major diastereoisomer was judged to be *cis*-form.

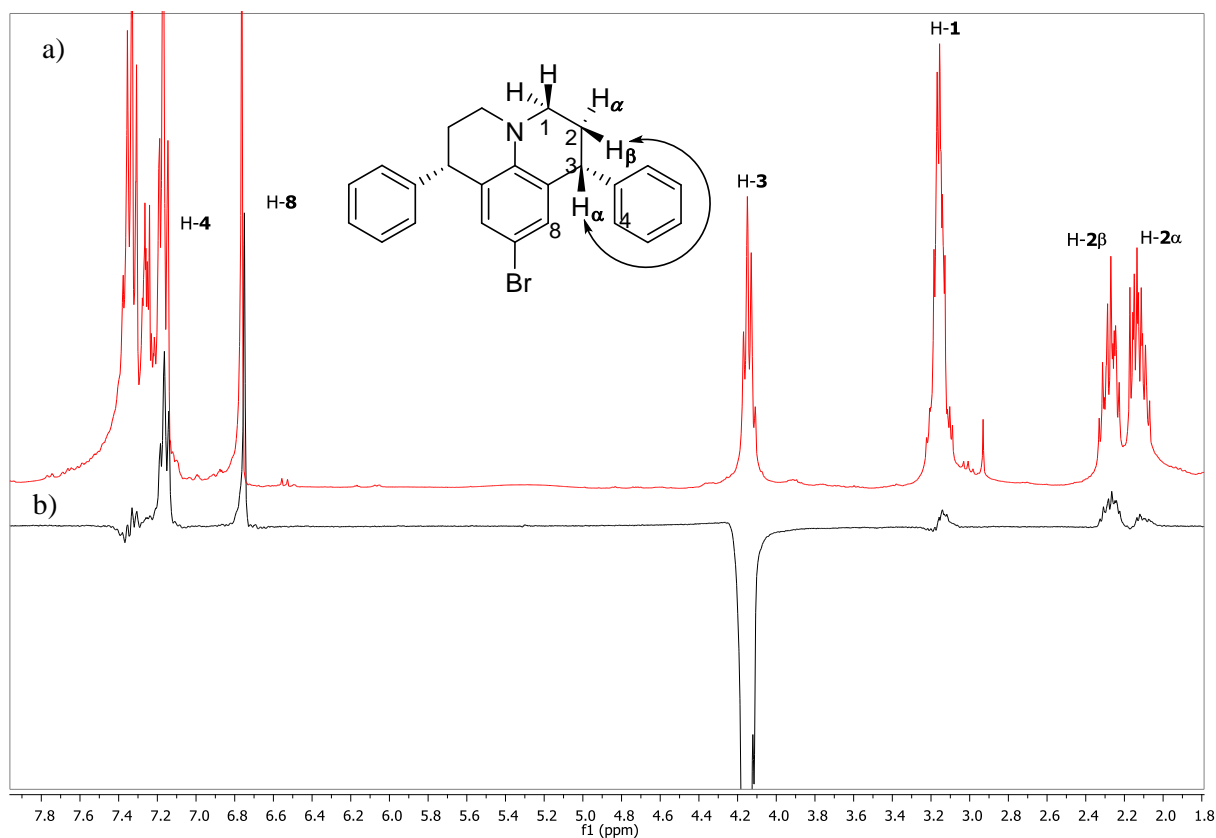


Figure S2 - a) ^1H NMR spectrum (300 MHz, CDCl_3 , 25 °C) of julolidine **4b**; b) Experiment NOEDiff selectively irradiating **H-3**.

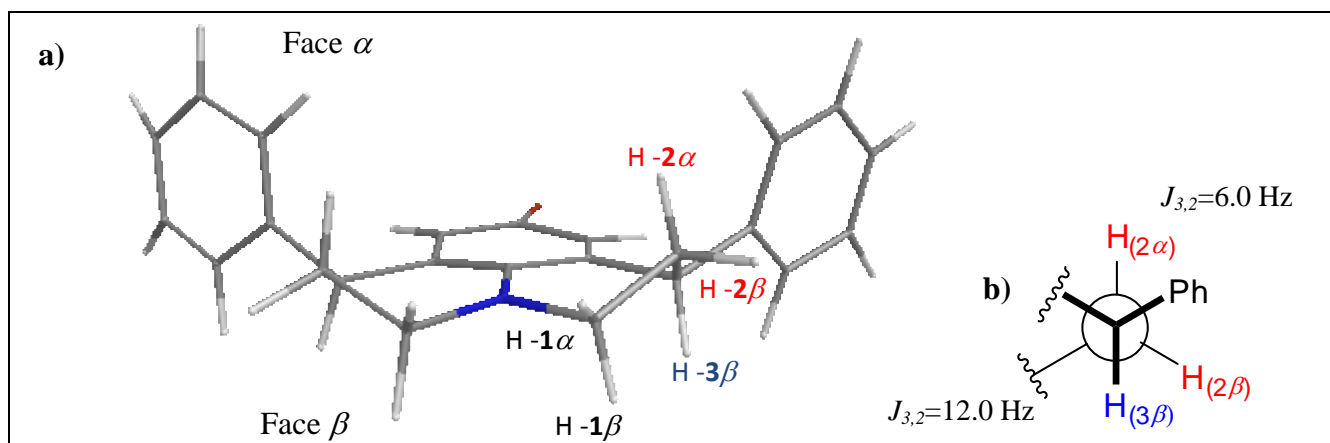


Figure S3 - a) 3D structure for *cis* diastereoisomer **4b**; b) Newman projection at C-2 and C-3.

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